GE

506
F85.5

UNIVERSITY of
PENNSYLVANIA
LIBRARIES

Rittenhouse Orrery

PROCEEDINGS

OF THE

CHEMICAL SECTION

OF THE

FRANKLIN INSTITUTE.

(VOL. III.—JAN.-DEC., 1891.)

PHILADELPHIA:

1892.

THE LIBRARY OF
THE UNIVERSITY OF

Press of
Edward Stern & Co.
31, 33 & 35 N. Tenth St.
Philadelphia.

INDEX.

VOL. III, 1891.

Acid, *p*-bromo-*m*-nitrobenzoic, salts of. (Hough), 120
Acids, the iodation of *p*-bromobenzoic. (Hough), 120
Amberite (or ambrite), on the occurrence of. (Emanuel), 14
Ammonia, supplement to the determination of the heat of evaporation, etc., of liquid. (Strombeck), 45
Apparatus for heating substances in glass tubes under pressure. (Pemberton), 34
Arsenides, metallic, the oxidation of, by the electric current. (Frankel), 122
Artesian well water, analysis of an. (Haines), 42
Assaying gold bullion, the use of cadmium in. (Whitehead), 94

Bartram (George H.). On a source of error in the determination of nitrates in water by the phenol sulphonic acid method, 31
Boiler scale, composition of, and the composition of the feed-water from Galveston, Tex. (Koenig), 74
Bye-products, the utilization of the, of the coke industry. (Terne), 104

Carbutt (John). The diazotype process of photographic dyeing and printing, 59
CHEMICAL SECTION:
  Annual report for the year 1891. By-laws and list of members. Proceedings, January to December, 1891, 1, 10, 16, 23, 36, 62, 78, 84, 119, 141
Chestnut-wood tannin. (Trimble), 80
Chromite, analysis of. (Pemberton), 33
Coke industry, the utilization of the bye-products of the. (Terne), 104

Diazotype process, the, of photographic dyeing and printing. (Carbutt), 59
Discussion of Terne's paper on the utilization of the bye-products of the coke industry, 116
Disease, notes on some cases of drinking water and. (Mason), 85
Drinking water, notes on some cases of, and disease. (Mason), 85

Electric current, the oxidation of the metallic arsenides by the. (Frankel), 122
Electrolysis, the, of the metallic sulphocyanides. (Frankel), 4
Emanuel (J. M.), On the occurrence of amberite, ambrite, or fossil gum, in a coal seam at Hawakawa Colliery, Bay of Islands, New Zealand, 14

Feed-water, composition of boiler scale and the composition of the, from Galveston, Tex. (Koenig), 74
Fluorides, on the heat of formation of. (Richards), 52
Fossil gum, on the occurrence of amberite, ambrite or, in a coal seam at Hawakawa Colliery, Bay of Islands, New Zealand, 14

178869

Frankel (Lee K.). The electrolysis of the metallic sulphocyanides, ... 4
  The oxidation of metallic arsenides by the electric current, . 122

Gold bullion, the use of cadmium in assaying. (Whitehead), ... 94
Gold, the electrolytic determination of. (Smith), ... 20

Haines (Reuben). Analysis of an artesian well water, ... 42
  On local standards in water analysis with special reference to Philadelphia and its vicinity, ... 24
  On the ammonia process of water analysis, ... 36
  On the percentage of iodine absorbed by lard oil by the Hübl method, ... 63
Heat of evaporation of liquid ammonia, supplement to the determination of the. (Strombeck), ... 45
Heat of formation of fluorides, on the. (Richards), ... 52
Heliochromy, Prof. Lippmann's. (Ives), ... 70
Hough (Oliver). I. The iodation of p-bromobenzoic acid. II. Salts of p-bromo-m-nitrobenzoic acid, ... 120

Iodation, the, of p-bromobenzoic acid. (Hough), ... 120
Iodine, on the percentage, absorbed by lard oil by the Hübl method. (Haines), 63
Ives (F. E.) Prof. Lippmann's heliochromy, ... 70

Koenig (George A.) Composition of boiler scale and the composition of the feed-water from Galveston, Tex., ... 74
  Is sulphuric hydrate volatile at the ordinary temperature of the air? 12

Lard oil, on the percentage of iodine absorbed by, by the Hübl method. (Haines), ... 63

Mason (William P.) Notes on some cases of drinking water and disease, . . 85
Mercury, the electrolytic determination of. (Smith), ... 18

National organization of chemists, resolutions on, ... 2
Nitrates, on a source of error in the determination of, in water by the phenol sulphonic acid method. (Bartram), ... 31

Oxidation, the, of metallic arsenides by the electric current. (Frankel), . . . 122

Pemberton, Jr. (H.) Analysis of a chromite, ... 33
  An apparatus for heating substances in glass tubes under pressure, ... 34
Photographic dyeing and printing, the diazotype process of. (Carbutt), ... 59
"Preservaline," a new preservative for meat. (Terne), ... 99

Resolutions on national organization, ... 2
Richards (Jos. W.). On the heat of formation of fluorides, ... 52
Rhodium, the electrolytic method applied to. (Smith), ... 17

Richards (Jos. W.) The specific heat of aluminium, ...

Salts of *p*-bromo-*m*-nitrobenzoic acid. (Hough), ... 120
Smith (Edgar F.). The electrolytic determination of gold, ... 20
The electrolytic determination of mercury, ... 18
The electrolytic method applied to rhodium, ... 17
Strombeck (Hans von). Supplement to the determination of the heat of evaporation, etc. of liquid ammonia, ... 45
Sulphocyanides, the electrolysis of the metallic (Frankel), ... 4

Tannin, chestnut-wood. (Trimble), ... 80
Terne (Bruno). The utilization of the bye-products of the coke industry, . . . 104
"Preservaline" a new preservative for meat, ... 99
Trimble (Henry). Chestnut-wood tannin, ... 80

Water, notes on some cases of drinking, and disease. (Mason), ... 85
analysis, on local standards in, with special reference to Philadelphia and vicinity (Haines), ... 24
analysis, on the ammonia process of. (Haines), ... 36
Whitehead (M. Cabell). The use of cadmium in assaying gold bullion, ... 94

By-Laws

of the

Chemical Section

of the

Franklin Institute.

I. In accordance with article xi, section 4, of the by-laws of the Institute, only members of the Institute may be elected to membership in the section: but sections are empowered to appoint associates, corresponding members and honorary members, *provided* that such appointments are sanctioned by the board of managers. Associates shall have the privilege of attending the meetings of the section and of participating in its scientific discussions, but shall not be entitled to vote. They shall be required to pay an annual assessment of two dollars ($2), payable in accordance with article iii.

II. The committee on admissions shall consist of seven members. They shall be elected annually. Four members shall constitute a quorum at all meetings of this committee. The adverse vote of two members shall be a rejection of a candidate. Applications for admission to the section shall be in writing and signed by one member of the section. They shall be referred to this committee after having been read before the section at a stated meeting. It shall be the duty of the committee, after careful consideration of the fitness of candidates, to vote on each name separately by ballot. This proceeding shall be secret and confidential. The committee shall send to the secretary of the section the names and addresses of the candidates elected. The committee shall have power to make its own rules of procedure.

III. Every member shall pay an initiation fee of one dollar ($1), and an annual contribution of two dollars ($2) in advance; but those elected to membership after October 1st shall pay no yearly dues for that year.

IV. Candidates elected to the section shall become members on payment of the initiation fee. If this fee is not paid within six months, the candidate's election shall be considered void. If the annual dues are not paid for a period of two years, due notice shall be given the member, and his name shall be stricken from the list.

V. The chemical apparatus, chemicals and other preparations belonging to the section, shall be under the care of the conservator, whose duty it shall be to see that they are kept in order and, if needed, readily accessible at the meetings of the section. He shall also attend to any minor repairs that may be necessary, and shall make an annual report to the section.

VI. The apparatus, reagents, etc., shall not be removed from the Franklin Institute building without consent of the conservator.

VII. A standing committee of two members shall be appointed yearly, who, with the secretary, shall be empowered to transact all financial business of the section, outside of the matters embraced in the duty of the treasurer. They shall pass all bills and shall audit the treasurer's account at the end of every year.

VIII. The stated meetings of the section shall be held on the third Tuesday of each month, except during July and August. Special meetings may be called by the secretary at any time, on application of seven members.

IX. At the stated meeting in November, nominations shall be made, and at that in December, an election shall take place for the following officers for the ensuing year:

President,
Two vice-presidents,
Secretary,
Treasurer,
Conservator.

The annual reports of the standing committees and officers shall be read at the December meeting.

X. The order of business for stated meetings shall be as follows:

(1) Correction of minutes of previous meeting.
(2) Nominations for membership.
(3) Report of committee on admissions.
(4) Reports of officers and correspondence.
(5) Reports of standing committees.
(6) Reports of special committees.
(7) Deferred business.
(8) New business.
(9) Communications and discussions.

XI. A quorum for the transaction of business shall consist of seven members.

XII. These by-laws may be temporarily suspended at any meeting of the section by unanimous consent of the members present. Amendments of a more permanent character may be made at any stated meeting by a vote of two-thirds of the members present; *provided*, that such amendments shall have been presented in writing and read before the section at the previous stated meeting.

Chemical Section

Officers—1891.

President,	Dr. Wm. H. Wahl.
Vice-presidents,	Mr. H. Pemberton, Jr. Dr. Wm. H. Greene,
Secretary,	Prof. Wm. C. Day,
Treasurer,	Dr. H. W. Jayne,
Conservator,	Dr. Wm. H. Wahl.

LIST OF MEMBERS.

A.

A. W. Allen,	Pencoyd Iron Works, Pencoyd, Pa
W. N. Allen,	No. 2 Chestnut Street.

B.

Geo. M. Beringer,	528 Arch Street.
Henry Bower,	28th and Gray's Ferry Road.
W. H. Bower,	28th and Gray's Ferry Road.
Chas. H. Boyer,	528 Linden Street, Camden, N. J.
G. Genge Browning,	44 North Front Street.
Chas. Bullock,	528 Arch Street.
Wm. A. Bullock,	528 Arch Street.

C.

John E. Carter,	Coulter and Knox Streets, Germantown.
Dr. C. M. Cresson,	413 Locust Street.
Philip S. Clarkson,	Quaker City Dye Works, 110 Oxford St.
J. H. Campbell,	Kingman, Mojave County, Arizona.
Harris Comer,	624 South Washington Square, Phila.

D.

Prof. W. C. Day,	Swarthmore College, Pa.

E.

J. H. Eastwick	Wissahickon Station.
A. T. Eastwick,	Isaac McHose & Sons, Norristown.

F.

R. A. Fisher,	2239 St. Alban's Place.
Lee K. Frankel,	University of Pennsylvania.
Dr. Persifor Frazer,	1042 Drexel Building.

G.

Dr. Wm. H. Greene,	204 North 36th Street.
Hugh A. Galt,	Kalion Chemical Company, 32d and Gray's Ferry Road.
F. Lynwood Garrison,	Radnor, Pa.
Albion D. Gray,	Penn Charter School, 8 South 12th Street.
Dr. F. A. Genth,	3937 Locust Street.

H.

Dr. S. C. Hooker,	Franklin Sugar Refinery.
Reuben Haines,	201 South 5th Street.
Prof. L. B. Hall,	Haverford College.
Thos. G. Hunter,	55th and Paschall Ave.
Oliver Hough,	325 South 16th Street.

I.

Fred. E. Ives,	Crosscup & West, 917 Filbert Street.

J.

E. C. Jayne,	242 Chestnut Street.
Dr. H. W. Jayne,	931 North Broad Street.

K.

Dr. Herbert M. Kaufmann,	1325 Franklin Street.
Dr. H. H. Keller,	University of Pennsylvania.
Dr. Geo. A. Koenig,	University of Pennsylvania.
Dr. E. H. Keiser,	Bryn Mawr College.

L.

Otto Lüthy,	2336 Fairmount Avenue.
M. Carey Lea,	430 Walnut Street.
John T. Lewis,	242 South 13th Street.

M.

Dr. W. P. Mason,	Renssellaer Polytechnic Institute, Troy, N. Y.
L. J. Matos	3943 Fairmount Avenue.
Prof. Henry Morton,	Stevens Institute of Technology, Hoboken, N. J.
Wm. W.Macfarlane,	J. M. Sharpless & Co., Chester, Pa.
Dr. Alex. Mucklé,	1323 North 19th Street.
Dr. L. I. Morris,	2505 Oxford Street.

N.

Thos. N. Newbold,	608 South 42d Street.
Geo. M. Newhall,	136 South Fourth Street.
Geo. L. Norris,	Pencoyd, Pa.

O.

Dr. E. L. Oatley,	4003 Chestnut Street.

P.

T. C. Palmer,	22 North Front Street.
H. Pemberton,	1947 Locust Street.
H. Pemberton, Jr.	1947 Locust Street.
Geo. B. Phillips,	622 Race Street.

R.

Prof. Jos. W. Richards,	Lehigh University, Bethlehem, Pa.
Frank H. Rosengarten,	17th and Bainbridge Streets.
W. L. Rowland,	4800 Chester Avenue.
Theo. D. Rand,	17 South 3d Street.

S.

Dr. Chas. Schaffer,	1309 Arch Street.
C. J. Semper	505 South 41st Street.
Prof. S. P. Sadtler,	204 North 34th Street.
Prof. Edgar F. Smith,	University of Pennsylvania.
H. G. Shaw,	Kalion Chemical Company, 32d and Gray's Ferry Road.
Herman Schanche,	Harrison Bros. & Co., 36th and Gray's Ferry Road.
Pedro G. Salom,	926, Drexel Building.
H. Warren Shepard,	523 Linden Street, Camden, N. J.
Waldron Shapleigh,	Welsbach Incandescent Light Works. Gloucester, N. J.
Hans von Strombeck,	104 Bank Street, New York City.
Alfred N. Seal,	407 Locust Street.

T.

Prof. H. Trimble,	632 Marshall Street.
Prof. N. Wiley Thomas,	Girard College.
Dr. D. K. Tuttle,	U. S. Mint, Philadelphia.
Dr. Bruno Terne,	Baugh & Sons' Chemical Works.

W.

Asa W. Whitney,	1815 Vine Street.
George C. Webster,	Media, Pa.
Dr. Wm. H. Wahl,	Franklin Institute.
W. D. Weikel,	Merchantsville, Camden Co., N. J.
F. H. Wyeth,	11th & Washington Avenue.
Dr. T. R. Wolf,	Newark, Del.
S. Lloyd Wiegand,	146 South 6th Street.
M. Cabell Whitehead,	Mint Bureau, Washington, D. C.
George Guest Williams,	24th and Bainbridge Streets.
George W. Whyte,	Camden Iron Works, Camden, N. J.

Y.

S. W. Young,	Swarthmore College, Swarthmore, Pa.

PROCEEDINGS
OF THE
CHEMICAL SECTION
OF THE
FRANKLIN INSTITUTE.

[*Stated meeting, held at the institute, Tuesday, January 20, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, January 20, 1891.

Dr. Wm. H. Wahl, president, in the chair.

Members present: Prof. E. F. Smith, Prof. L. B. Hall, Mr. George L. Norris, Dr. Geo. A. Koenig, Dr. E. H. Keiser, Dr. D. K. Tuttle, Dr. S. C. Hooker, Mr. Lee K. Frankel, Mr. H. Pemberton, Jr., Mr. Henry Bower, Mr. W. H. Bower, Mr. L. E. Williams, Prof. Henry Trimble, Mr. A. A. Moore.

The annual report of the treasurer was read and approved.

The resignation of Mr. C. V. Petraeus was received and accepted.

The report of Mr. H. Pemberton, Jr., as chairman of the committee of conference of the Chemical Section, appointed to confer with a similar committee of the American Chemical Society, was read and accepted. This committee was appointed by the president a few days after the last meeting of the section in December, and in response to a request for such a committee from Mr. A. A. Breneman, chairman of the committee of arrangements of the American Chemical Society.

The object of this conference was to consider, in a preliminary way, the question of forming a general organization of American chemists, who should thus constitute a national society. A general meeting of eighteen delegates representing seven different chemical organizations was held in connection with the general meeting of the American Chemical Society at the University of Pennsylvania, on the 30th of December. On the following day, a meeting of the chairmen of the various committees of conference was held at the Manufacturers' Club, in Philadelphia, and, as a result of the two meetings, a set of resolutions was adopted, a copy of which was submitted by Mr. Pemberton as a part of his report to the section.*

Inasmuch as another meeting of the various conference committees is provided for in the above-mentioned resolutions, the committee was continued for the performance of such duties as were implied in the resolutions. After Mr. Pemberton's report had been accepted, the president extended the thanks of the section to the committee for its action.

---

* Copy of these resolutions is appended.

The following gentlemen were proposed as candidates for membership in the section:

Mr. Geo. Guest Williams, Twenty-fourth and Bainbridge Streets, Philadelphia.

Mr. H. Warren Shepard, 523 Linden Street, Camden, N. J.

Mr. Everett W. Frazer, 915 Ridge Avenue, Philadelphia.

Mr. Edward Gudeman, 931 N. Twelfth Street, Philadelphia.

Mr. Harris Comer, 624 South Washington Square, Philadelphia.

Prof. Albion D. Gray, Penn Charter School, No. 8 S. Twelfth Street, Philadelphia.

Mr. Waldron Shapleigh, Welsbach Incandescent Gas Light Company, Gloucester, N. J.

Dr. Bruno Terné, Baugh & Sons' Chemical Works, Philadelphia.

Mr. Frank H. Rosengarten, Seventeenth and Bainbridge Streets, Philadelphia.

The names were voted upon by the committee on admission, and all were elected.

Mr. Lee K. Frankel then read a paper "On the electrolysis of the metallic sulpho-cyanides." (Referred for publication.)

Prof. Geo. A. Koenig followed with a paper, entitled "Is sulphuric hydrate volatile at ordinary temperatures?" It was also referred for publication.

Prof. Koenig's observations and experiments tended towards an affirmative answer of the question which formed the title of his paper, and some interesting discussion was evoked.

Dr. Tuttle referred to recorded experiments, in which the absence of change in solutions of barium salts, exposed to the possible evaporation of sulphuric acid tended to prove the non-volatility of the acid. Prof. Smith cited some observations made by himself in connection with electrically deposited mercury, in which a weight of 0·3 grams of that metal lost in the course of something less than twenty-four hours a weight of 0·002 grams presumably by evaporation.

The paper by Dr. Hans v. Strombeck, "On the specific heat of brines of different specific gravity; and on the determination of the specific heat of a body generally," was read by title and referred for publication.

A paper from Mr. J. M. Emanuel, U. S. N., "On the occurrence of amberite, ambrite or fossil gum, in a coal seam at Hawakawa colliery, Bay of Islands, N. Z., was read by the secretary, and was referred for publication.

Prof. Smith then presented a paper "On the electrolytic separation of certain metals in phosphate solutions." It was referred for publication.

After a number of interesting comments upon Prof. Smith's contribution, the section adjourned. WM. C. DAY, *Secretary.*

Resolutions adopted at a conference of chemists, assembled for considering the formation of a national organization, held December 30 and 31, 1890, at the University of Pennsylvania, Philadelphia.

About eighteen delegates from the following chemical societies were present; to wit:

(1) American Association for the Advancement of Science, Chemical Section.
(2) American Chemical Society.
(3) Franklin Institute, Chemical Section.
(4) Brooklyn Institute, Chemical Section.
(5) Association of Official Agricultural Chemists.
(6) Chemical Society of Washington.
(7) Manufacturing Chemists' Association of the United States.

Prof. A. B. Prescott in the chair.

Resolution 1. It is desirable that an American Association of chemists be formed to embrace all existing American chemical organizations.

Resolution 2. Resolved that this conference recommend to all existing American chemical organizations that they call a meeting of their bodies to be held in Washington in connection with the meeting of the American Association for the Advancement of Science for 1891, and that each of these organizations be requested to appoint a committee, or to continue their present committee for the further discussion of the subject submitted to the conference now in session.

Resolution 3. Resolved that this general conference committee composed of the present sub-committees or such others as may be appointed by the several organizations, be called together at as early a time as practicable before the joint meeting recommended in the resolution adopted.

Resolution 4. Resolved that meanwhile each sub-committee, through its chairman, shall formulate such modifications of the constitution of the American Chemical Society as it shall deem necessary to adapt it to the requirements of the association proposed.

Resolution 5. Resolved that the chairmen of these sub-committees shall then, so far as possible, harmonize the views embodied in these reports of their several organizations, and shall have printed for presentation at the joint meeting a report, or majority and minority reports, on a constitution for the proposed association of American chemists.

Voted that the chairman of this conference, with Prof. Clarke and Prof. Hale, be a committee of three to select time and place for the meeting called for in resolution No. 3.

Voted to request the American Chemical Society to print the minutes of this conference in their proceedings of the Philadelphia meeting, and to mail copies as widely as possible to chemists in North America.

The secretary of this conference was desired to communicate the above resolutions to scientific journals with a view to obtain a wide publication of the same.

Adjourned to meet at call of the chair.

H. CARRINGTON BOLTON,
Secretary.

COMMITTEE OF CONFERENCE, WITH SOCIETIES REPRESENTED.

Dr. A. C. Peale, United States Geological Survey, Washington, D. C., representing the Chemical Society of Washington.

Prof. F. W. Clarke, United States Geological Survey, Washington, D. C., representing the American Association for the Advancement of Science.

Dr. H. W. Wiley, Department of Agriculture, Washington, D. C., representing the Official Agricultural Chemists' Association.

Mr. H. Pemberton, Jr., Twenty-ninth and Gray's Ferry Road, Philadelphia, Pa., representing the Chemical Section of the Franklin Institute.

Mr. Henry Bower, Twenty-ninth and Gray's Ferry Road, Philadelphia, Pa., representing the Manufacturing Chemists' Association of the United States.

Dr. Walter H. Kent, 64 Livingston Street, Brooklyn, N. Y., representing the Brooklyn Institute.

Dr. E. Waller, School of Mines, Columbia College, New York city, representing the American Chemical Society.

THE ELECTROLYSIS OF THE METALLIC SULPHOCYANIDES.

By Lee K. Frankel.

[*Read before the Chemical Section, January 20, 1891.*]

In a paper published by Dr. Smith and the author, in the Franklin Institute *Journal* for August, 1889, the statement is made that manganese, when deposited from a solution containing an excess of potassium sulphocyanide, separates as a grayish white compact deposit on the negative pole, differing in this respect from solutions of the nitrate or the sulphate from which manganese is deposited as oxide. Furthermore, it is stated that nickel, cobalt, iron and several other metals separate very rapidly from cold sulphocyanide solutions under the influence of a weak current. In the following paper, the above experiments have been repeated, and the action of the current has been tried on various other metallic sulphocyanides. The results obtained have been, for the most part, of a negative order, but are here appended, as they illustrate some new facts in electro-chemical analysis.

Decomposition of Alkaline Sulphocyanides.—If a concentrated aqueous solution of potassium or ammonium sulphocyanides (300 grams in one litre) is subjected to the action of a weak current (1·5 cc. OH gas per minute), the solution at first remains clear. After from one to two hours it gradually becomes turbid, and an odor of hydrocyanic acid is readily perceptible. If the current is allowed to run for twelve hours, the turbidity constantly increases until, at length, the solution is filled with a lemon-yellow amorphous deposit. According to Bunge (*Ber.* 3, 297), who investigated the action of the current on potassium sulphocyanide, and to Lidow (*Ber.* 17, ref. 252), who obtained similar results with ammonium sulphocyanide, this yellow deposit is pseudosulphocyanogen.

If, however, the solution, while being electrolized, is heated on a water-bath, there is evolved along with the pseudosulphocyanogen an unbearable sickening odor, due in all probability to the formation of organic sulphur compounds. In dilute sulphocyanide solutions, however, the formation of the lemon-yellow compound takes place in but small quantities, and only after the lapse of considerable time, so that if the current be sufficiently weak and the solution sufficiently dilute, no turbidity whatever occurs in the solution. It was anticipated that this behavior of the dilute solution could be utilized for the electrolytic deposition of the metals, but the other products of decomposition exerted such an influence on the solution that in but very few cases were quantitative results obtained. These are given below as they were found.

Mercury.—Mercury can be completely deposited from solutions of potassium or ammonium sulphocyanide. The metal separates very rapidly from the respective solutions, and resembles the deposit obtained in the electrolysis of the double cyanide of mercury and potassium, in that it never possesses a drop-like appearance, but is dense and coherent.

In the first determination a slight turbidity occurred, due to the larger quantity of ammonium sulphocyanide. The filtrates from all the four determinations gave the blood-red color with ferric chloride, but did not darken on the addition of ammonium sulphide. The deposits were washed, first with cold then with hot water, and eventually dried on the edge of a warm iron plate.

	Mercury Present in Grams.	Ammonium Sulphocyanide in Grams.	Time.	Current per Minute.	Dilution.	Mercury Found in Grams.
(1)	·2292	1·5	16 hours.	1· cc. OH gas	75 cc.	·2289
(2)	·2292	·9	16 hours.	1·4 cc. OH gas	75 cc.	·2285
(3)	·2292	·9	16 hours.	·65 cc. OH gas	75 cc.	·2295
(4)	·2292	1·2	16 hours.	·65 cc. OH gas	75 cc.	·2294

Gold.—Like mercury, gold can be completely deposited from a solution of ammonium sulphocyanide. The metal separates as a compact, firmly adherent deposit, which can readily be washed with either hot or cold water. The conditions, under which the deposits were obtained, are as follows:

(1) To a solution of gold chloride containing 0·0185 gram of gold, 1·5 grams of ammonium sulphocyanide were added, along with 150 cc. of water. A current of 1 cc. OH gas per minute was allowed to act for six hours, at the end of which time, the metal was completely deposited. The gold found weighed 0·0183 gram.

(2) The conditions in this determination were like the above, excepting that the gold chloride solution contained ·1443 gram of gold, and that the current was allowed to act for sixteen hours. The resultant gold weighed ·1439 gram.

Cadmium.—If ammonium sulphocyanide is added to a solution of cadmium sulphate, the solution remains clear. If this solution be now subjected to the action of the current, the cadmium immediately deposits as metal, but in a very spongy form. This sponginess is frequently of such an extent, that the deposit spreads in a continuous layer from the negative to the positive pole, and readily detaches itself when washed. Various conditions of current and solution were tried in order to remedy this result, the current used varying from 0·25 cc. to 2·2 cc. OH gas per minute, and the amount of ammonium sulphocyanide from ·3 gram to six grams in solutions diluted from fifty to 200 cc. In all cases, however, the cadmium deposited in a spongy form, and the method had to be abandoned.

Palladium, Nickel, Cobalt and Zinc.—In the electrolysis of neutral solutions of these four metals in the presence of ammonium sulphocyanide, similar reactions took place. In each instance, the metal began to deposit immediately with currents ranging from one to two cc. OH gas per minute, in solutions averaging one gram of ammonium sulphocyanide. In the case of the nickel and the cobalt, the metals deposited in a compact metallic form, and frequently could be separated as a thin film from the sides of the platinum dish. With all four metals, however, the deposition continued only to a certain point, after which a reverse action took place and the coatings gradually dissolved. In the case of the zinc, after permitting the current to act for twenty-four hours, every portion of the gray metallic deposit obtained in the earlier stage of the operation had gone into solution. The probable cause for this singular action lies in the fact that in the decomposition of the alkaline sulphocyanides, there is formed an estimable amount of alkaline cyanide which, in the experiments above referred to, could be easily recognized by its odor. The addition of ammonia to the solution from time to time during the passing of the current, gave no beneficial results, and all attempts to deposit the metals completely, with the strength of current used, proved futile.

Iron and Manganese.—The continuation of the investigation previously reported on these metals, led to no satisfactory results. As has been stated, the metals can be deposited from solutions of their sulphocyanides, but not completely, and the tendency to oxidize is so great, that films of the oxides form on the edges of the solutions, even during the action of the current. As soon as the solutions are poured off, and the surfaces of the metals are exposed to the air, these films of oxide rapidly spread over the entire deposits, and exclude any possibility of the estimation of iron or manganese by this method.

Arsenic.—Varying quantities of ammonium sulphocyanide were added to solutions of sodium arsenate and of sodium arsenite made alkaline with sodium hydrate. In no case was there the faintest deposition of metal.

Lead.—It has already been shown that when a solution of lead nitrate is subjected to the action of the electric current, the lead will deposit as peroxide on the positive pole. If, now, ammonium sulphocyanide be added to the solution, while the current is passing the lead will deport itself similarly to the manganese, in that the peroxide of lead gradually dissolves off the anode, while the metal deposits on the cathode. This deposition of metal will continue until no more lead can be detected in the filtrate, but, while the greater portion of the lead has separated as metal on the negative pole, a white coating will now be found on the positive pole, which after solution in acids, gives a reaction with hydrogen sulphide for lead. This coating on the anode prevents any quantitative estimation of lead in an ammonium sulphocyanide solution. The metal as deposited from such a solution has a gray metallic appearance, is but loosely adherent to the dish, and easily becomes covered with a yellow film of oxide.

Antimony, Bismuth and Tin.—To the hydrochloric acid solutions of these metals, ammonia was added until precipitates formed, varying quantities of ammonium sulphocyanide were then added to the respective solutions, followed by hydrochloric acid, until the precipitates just dissolved. All three metals deposit rapidly from such solutions, the tin, however, but incompletely. The filtrate from the bismuth gave no reaction for the metal, but the deposit was so spongy that it could not be handled. The antimony deposit detached itself so readily from the sides of the dish on which it separated, that no effort was made to discover if quantitative results could be obtained.

Pseudosulphocyanogen.—In a paper on the preparation of a new yellow dye color, H. O. Miller (*Ber.* 18, ref. 676) states that the impure compounds, which he designates "Kanarin," is obtained by the action of hydrochloric acid and potassium chlorate on potassium sulphocyanide. The resulting yellow substance dissolves in potassium hydrate solution, from which alcohol deposits the potassium salt. If the latter is filtered off and dissolved in water, hydrochloric acid reprecipitates the dyestuff. As noted above, Lidow (*Ber.* 17, ref. 252) asserts that the yellow amorphous compound obtained in the electrolysis of ammonium sulphocyanide is pseudosulphocyanogen, the yield being greatest at 50° C., and, furthermore, states that kanarin and pseudosulphocyanogen are identical.

In a still later paper, W. Markonikow (*Ber.* 17, ref. 279) denies that kanarin and pseudosulphocyanogen are identical bodies. In proof of this, he states that if pseudosulphocyanogen is dissolved in an equal volume of potassium hydrate diluted with twenty parts of water, it is converted into potassium sulphocyanide and potassium cyanate, while if kanarin undergoes a similar treatment, the potassium salt is obtained, which, as above stated, can be precipitated by alcohol. To prove the correctness or fallacy of these statements, the following experiments were made:

A solution of ammonium sulphocyanide, containing 300 grams of the salt dissolved in a litre of water, was electrolized with a current generating two cc. OH gas per minute, for forty-eight hours. The yellow compound, which had separated, was filtered off and washed with hot water, until the washings no longer gave the blood-red coloration with a solution of ferric chloride, and dried at 100° C. The resulting lemon-yellow compound dissolved readily in concentrated sulphuric acid, but without any evolution of sulphur dioxide, a reaction which Markonikow gives as distinctive for kanarin. The yellow substance dissolves in potassium hydrate, more readily on heating, to a yellow solution. A portion of this solution, after acidifying with dilute nitric acid, and the addition of ferric chloride, gave not the faintest reaction for potassium sulphocyanide. To the remainder of the solution, alcohol was added. The turbidity that formed, gradually settled to the bottom of the liquid in oily drops. These were separated from the supernatant liquid by means of a separatory funnel, dissolved in water, and from this solution the lemon-yellow compound thrown out by means of hydrochloric acid. If these reactions are indicative, kanarin and pseudosulphocyanogen are identical, but the compound obtained in the electrolysis of ammonium sulphocyanide is not pseudosulphocyanogen.

The action of potassium chlorate and hydrochloric acid on ammonium sulphocyanide was also tried, the results being similar to those obtained by Miller and Markonikow with potassium sulphocyanide. The compound thus obtained has a reddish yellow color, dissolves in potassium hydrate, the resulting solution giving a reaction for potassium sulphocyanide, and forming the potassium salt with alcohol, showing that the original substance is impure. The potassium salt dissolved in water, and treated with hydrochloric acid, now gives a lemon-yellow precipitate resembling in color that obtained by the electrolysis of the ammonium sulphocyanide.

The author reserves, for a future communication, the investigation of the composition of these compounds, and in conclusion wishes to extend his thanks to Dr. Edgar F. Smith, under whose supervision, and at whose instance, the above work was undertaken.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, January 13, 1891.

PROCEEDINGS.

[*Stated meeting, held at the institute, Tuesday, February 17, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, February 17, 1891.

Dr. WM. H. WAHL, president, in the chair.

Members present: Dr. L. B. Hall, Prof. E. F. Smith, Dr. H. W. Jayne, Mr. H. Pemberton, Jr., Mr. W. H. Bower, Mr. A. W. Allen, Mr. Reuben Haines, Mr. R. A. Fisher, Mr. C. S. Boyer, Mr. H. Warren Shepard, Mr. Everett W. Frazer and four visitors.

Mr. Pemberton nominated Dr. F. A. Genth as an honorary member of the section.

Dr. Wahl nominated Dr. Hans v. Strombeck, 104 Bank Street, New York City, and Prof. Joseph W. Richards, Lehigh University, Bethlehem, Pa., as associate members. The nominations were referred to the committee on admissions and the candidates were elected.

The treasurer read a letter from the actuary of the institute in reference to the payment of bills for subscriptions; the bills accompanying the letter were referred to the finance committee, which endorsed them for payment.

The treasurer also reported two names to be dropped from the list of members.

The resignations of Prof. R. L. Chase and Mr. Henry Warden were received and accepted.

Dr. Wahl, on behalf of Dr. Greene and himself, made a brief reply to a criticism upon their note on "Alloys of Sodium and Lead," in the *Chemical News*, of January 2, 1891. It was alleged in this criticism that the calculated densities for the alloys, given by the authors, were erroneous, and other figures were stated as the correct densities. The speaker showed wherein the critic had made an elementary mistake, and that the figures given by the authors were right.

Samples of the hydrofluoric acid bottles, patented recently by Prof. Edward Hart, of Easton, Pa., were exhibited.

Prof. Smith presented three papers, entitled, respectively, "The electrolytic method applied to rhodium," "The electrolytic determination of gold" and "The electrolytic determination of mercury."

They were listened to with marked interest and were referred for publication.

Mr. Reuben Haines presented a preliminary paper on the adoption of standards in interpreting the results of water analyses. He considered at length the variability of these standards among different chemists and in different parts of the country. The following figures representing the averages of thirty-four different determinations of uncontaminated waters were recommended as standards for pure waters in the neighborhood of Philadelphia:

	Parts in 100,000.
Free ammonia,	·0031
Alb. ammonia,	·0044
Chlorine,	1·19
Nitrogen in nitric acid,	·5075
Total solids,	12·57

After some discussion of this paper the section adjourned.

Wm. C. Day, *Secretary.*

Is SULPHURIC HYDRATE VOLATILE AT THE ORDINARY TEMPERATURE OF THE AIR?

By George A. Koenig.

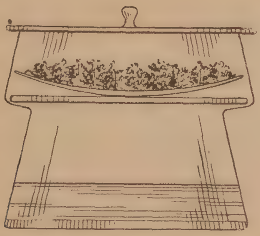
[*Read before the Chemical Section, January 20, 1891.*]

The question proposed in the heading of this communication arose under the following circumstances: I had received a number of skeleton crystals of metallic iron, which had formed in a steel block. To prevent them from rusting, they had been coated with shellac. Previous to the analysis, the shellac was removed by alcohol, and after drying on water-bath, the material not needed for the purpose in view was placed upon a perfectly clean watch-glass into a desiccator of the common pattern. The watch-glass was supported by an iron-wire triangle; its rims did not touch the sides of the desiccator. Upon the latter's bottom was pure sulphuric acid, about one inch deep. The lid fitted with a film of vaseline. The desiccator was then placed upon a shelf and remained there undisturbed for about nine months. Being needed for another purpose, I took it down, and found to my astonishment that both the iron-wire triangle and the iron crystals were covered with a clean white crust. What could this crust be? My first supposition reverted to the nitrous compounds frequently found even in redistilled sulphuric acid. The crust was very coherent and peeled off in scales, leaving a bright metallic surface. I noticed that those parts of triangle, which had rested in immediate contact with the glass, were not incrusted. Likewise the watch-glass was bright and free from dust. The crust dissolved readily in distilled water, and proved to be composed of *anhydrous ferrous sulphate.* The test for nitric and nitrous acid resulted negatively. A quantitative analysis was not made under the circumstances.

How was this ferrous sulphate formed? Two possibilities only seem to present themselves:

(*a*) The acid has crept up the side of the vessel, and also from the triangle along the watch-glass, by capillary force. This hypothesis is not well sustained. In the first place the sides proved themselves dry and clean, and so did the watch-glass. In the second place, one should expect the strongest action, where the triangle rested on the glass. But the fact obtained that these contacts were not corroded.

(*b*) The acid is volatile at ordinary temperature, similarly to other liquids with high boiling point, such as mercury. It might even be proposed that this volatilization is induced by the strong basic character of metallic iron; and the minute quantities volatilized, being immediately absorbed by the iron, there would not be any appreciable tension. There must have been produced, of course, a corresponding quantity of hydrogen, which would cause tension. I neglected to collect at once the gas in the desiccator and a test was thus impossible. On the other hand, the lid was not so tight, but that so light a gas could not readily escape.



There seems to me at present no escape from admitting the volatility of sulphuric hydrate at temperatures not exceeding 30° C., and more particularly in the presence of bodies exerting chemical attraction.

It will be probably of use to many to bear this fact in mind, when they employ sulphuric acid as a desiccating medium. I propose to institute—and, in fact, have already instituted, several sets of conditions, for proving or disproving this volatilization. They will necessarily be time-taking, as time seems the chief factor in the case.

CORRESPONDENCE.

ON THE OCCURRENCE OF AMBERITE, AMBRITE, OR FOSSIL GUM IN A COAL-SEAM AT HAWAKAWA COLLIERY, BAY OF ISLANDS, NEW ZEALAND.

[*Presented at the stated meeting of the Section, held January 20, 1891.*]

U. S. S. Mohican, OPUA, BAY OF ISLANDS,
NEW ZEALAND, September 13, 1890.

To the Chemical Section, Franklin Institute:

GENTLEMEN:—I have the honor of presenting to the Section, a specimen of coal from the Hawakawa Colliery, Bay of Islands, New Zealand.

This specimen I obtained at the mine, and for this detailed report of its characteristics, I am indebted to Mr. T. P. Moody, M.E., etc., member of the Geological Society of Australia.

Subject—"On the occurrence of amberite, ambrite, or fossil gum in a coal-seam at Hawakawa Colliery, Bay of Islands, New Zealand."

"I desire to place on record in the annals of our society a brief description of a most peculiar substance, which is often met with during the progress of coal-getting at this colliery. I refer to 'amberite' or 'fossil gum.'

"This is a gum or resin (mineral), and like most bitumens, it contains upwards of ten per cent. of oxygen, and, also, nearly the same proportion of hydrogen. It bears a close resemblance to Kauri gum.

"This peculiar substance, namely, amberite, imbedded in a coal-seam, has never been seen anywhere, but at the Bay of Islands, at Waikato and at Uhangarei, in the colony of New Zealand.

"In association and intermixed with these coals, especially at the Bay of Islands, large quantities are obtained. It frequently occurs in large masses, but generally is found in layers of small extent, and in 'nodules' extensively imbedded and disseminated over the coal face.

"It is thus described: Its hardness may be represented by two; specific gravity, 1·034; lustre, greasy; color, yellowish-gray, sometimes light and dark green and occasionally encrusted with a 'film' of carbonate of lime and spar; subtransparent; fracture, conchoidal; its chemical composition:

Carbon,	76·88
Hydrogen,	10·54
Oxygen,	12·77

"It is wholly insoluble in alcohol, ether, oil of turpentine, benzole and chloroform and dilute acid. It burns with a yellowish smoking flame. The ash contains iron, lime and soda.

"This amberite is an exudation from the Kauri pine tree, changed by chemical action, the only difference between it and Kauri gum being in color mainly. This amberite occurs in one seam of coal which belongs to the cretaceo-tertiary formation. In this series here there is only one seam of coal.

"The secondary formation of other countries, is, in this place, entirely absent, therefore the cretaceo-tertiary formation necessarily reposes upon the primary, viz: 'diorite slate.'

"In order that comparisons may be made as to other products somewhat bearing a resemblance to amberite, I give a few particulars of *re* gums or resins which are found in Europe.

"For instance, the amber of the Baltic Coast occurs in irregular mains, without cleavage. Its hardness is 2·25; specific gravity, 1·065 to 1·081; lustre, resinous; color, yellow; it is, however, sometimes reddish, brownish and whitish, often clouded; streak white; transparent; tasteless; electric on friction. Composition:

Carbon,	78·824
Hydrogen,	10·228
Oxygen,	10·900

"Then, again, the substance well-known to scientists as 'geomyricite.' This in color is 'wax-like' white; melts at 80° to 90° F.; is easily soluble in hot alcohol and ether, but slightly only in alcohol of 80 per cent. This is thought to be the resin exuded from some palm tree. Its composition:

Carbon,	80·59
Hydrogen,	13·42
Oxygen,	5·99

"This substance is almost identical with 'China wax.'

"In concluding I would briefly remark that all the gums referred to are, according to common opinion, the exudations of trees that flourished at the time the deposits were forming in which these substances are found."

Before closing I will state my experience with this coal as fuel for steaming purposes.

I have used this coal in the furnaces of the boilers of the United States steamer *Mohican* and find it to be a good coal for that purpose. Combustion is more rapid than with any other bituminous coal I have ever used.

It does not make any ash, but deposits a cinder or clinker upon the surface of the grate bars. This deposit is easily removed, as upon opening the furnace door to manipulate the furnace, the cold air being admitted, the cinder immediately detaches itself from the bars and is removed in the ordinary way. This cinder (a specimen of which I send) amounts to about eight per cent. of the coal consumed in the furnace. The smoke is of a light pearly-gray color.

Very respectfully,
J. M. EMANUEL,
Passed Assistant Engineer, U. S. N.

PROCEEDINGS.

[*Stated meeting, held at the institute, Tuesday, March 17, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, March 17, 1891.

Dr. WM. H. WAHL, president, in the chair.

There were present fifteen members and four visitors.

Letters from Dr. F. A. Genth and Prof. Joseph W. Richards, acknowledging election to membership, were read.

Mr. George H. Bartram read an interesting paper on "A source of error in the phenol-sulphuric acid method of determining nitrates in potable waters."

The paper was commented upon by Mr. Reuben Haines, who remarked that in his experience in the use of this method he had suspected the existence of such a source of error as was pointed out in Mr. Bartram's paper.

Mr. Fred. E. Ives read a paper criticising adversely the results obtained by Prof. Lippmann in photographing colors. The paper was discussed by Messrs. Hall, Wahl, Jayne and Haines; considerable interest was manifested in the paper.

Mr. Reuben Haines then read a paper, entitled "Percentage of iodine absorbed by lard oil."

Mr. H. Pemberton, Jr., presented two papers, entitled, respectively, "Analysis of a chromite" and "An apparatus for heating substances in glass tubes;" they were read by title. The papers presented were referred for publication.

Adjourned. WM. C. DAY, *Secretary*.

THE ELECTROLYTIC METHOD APPLIED TO RHODIUM.

By Edgar F. Smith.

[*Read at the stated meeting, held February 17, 1891.*]

So far as I have been able to learn, the salts of rhodium have never been subjected to the action of the electric current. I, therefore, made experiments in this direction and obtained results indicating the possibility of employing the electrolytic method in the estimation of this metal. The various texts consulted led me to believe that in all likelihood a solution of the double cyanide of rhodium and an alkali metal would best answer my purposes. Precipitation did not occur upon mixing solutions of potassium cyanide and rhodio-sodium chloride. The liquid remained clear. As soon, however, as a comparatively feeble current acted upon the double cyanide, a reddish yellow colored compound appeared, and remained suspended in the liquid. It was probably a cyanide which sustained no change. I did not attempt a repetition of this experiment.

From my experience in the electrolysis of gold, platinum and palladium solutions containing alkaline phosphates and free phosphoric acid, I concluded to try rhodium under similar conditions. Sodium rhodium chloride, $Na_6Rh_2Cl_6 + 24H_2O$, was the salt used by me. A sufficient quantity of it was dissolved so that 10 cc. of liquid contained, by calculation, 0·0980 gram of metallic rhodium.

Experiments.—(1) To 10 cc. of the rhodium solution were added 30 cc. of sodium phosphate, Na_2HPO_4 (sp. gr. 1·0358), and 3 cc. of phosphoric acid (sp. gr. 1·347). The total dilution of the electrolyte was 180 cc. The current gave 1·8 cc. OH gas per minute. In seven hours the deposition of metal was finished.

Weight of crucible + rhodium = 63·4765
" " " alone, = 63·3783

Rhodium = 0·0982

The deposition of metal occurred at the ordinary temperature. At the beginning of the decomposition the liquid showed a beautiful deep purple color, but as the metal separated, it rapidly became lighter and finally colorless. Upon inclining the dish in which the precipitation was made, thus exposing a fresh metal surface, the latter remained perfectly clear. The precipitation of metal was completed.

(2) The conditions here were nearly the same as in the preceding trial. The total dilution of liquid equalled 200 cc. while the current gave 1·6 cc. of OH gas per minute.

The metallic rhodium was precipitated upon copper-plated platinum dishes. It was rather black in color, very compact and perfectly adherent. It was washed without any difficulty. Hot water was used for this purpose. The drying was done upon a warm iron plate.

The results obtained accord so well with the theory that the accuracy of the method cannot be questioned. The rapidity with which the metal is deposited, and the ease with which it may be handled also recommend this method of estimation.

Chemical Laboratory of the Univ. of Pa.,
Philadelphia, February 13, 1891.

The ELECTROLYTIC DETERMINATION of MERCURY.

By Edgar F. Smith.

[*Read at the stated meeting, held February 17, 1891.*]

In gravimetric analysis mercury is frequently obtained as sulphide. To weigh it as such, or to convert it into some form suitable for weighing, requires much time and close attention to insure results that will be at all satisfactory. It is, therefore, better to have recourse to the electrolytic method of determination. As mercury sulphide dissolves quite readily in the fixed alkaline sulphides, I electrolyzed such solutions. The results show that this procedure affords a very accurate and clean method for the estimation of this metal.

The sodium sulphide was prepared as described in the paper relating to the determination of gold. Its specific gravity was 1·19.

Solutions of mercuric chloride, containing a known amount of metal, were first tried. The table shows the conditions of experiment and the results:

Mercury present in grams.	Sodium sulphide present. Sp. gr. 1·19.	Total dilution.	Current in cc. OH gas per minute.	Mercury found.
0·1903	20 cc.	125 cc.	1 cc.	0·1902
0·1903	20 cc.	125 cc.	1 cc.	0·1905
0·1903	20 cc.	125 cc.	1 cc.	0 1907
0·1903	20 cc.	130 cc.	1·2 cc.	0·1910
0·1903	30 cc.	130 cc.	1·2 cc.	0·1900

The precipitation extended through the night. The deposited mercury was gray in color and very compact. Only once was a tendency to the fluid form observed. Hot water was used for washing. The metal was dried by holding the platinum dish in the palm of the hand and blowing gently upon the deposit.

If mercury and arsenic are both present in a solution of sodium sulphide, the current will throw out the former. It will not carry down any arsenic. This is evident from the two analyses that follow:

Mercury present.	Arsenic present.	Sodium sulphide.	Total dilution.	Current in cc. OH gas per minute.	Mercury found.
0·1903 gr.	100 %	25 cc.	125 cc.	2 cc.	0·1908 gr.
0·1903 gr.	100 %	25 cc.	125 cc.	2 cc.	0·1894 gr.

In the communication upon the deposition of gold from sodium sulphide solutions, mention is made that gold and tin could not be separated electrolytically when present together in a solution of that kind. I was, therefore, rather surprised to discover that mercury could be separated from tin under such circumstances. The conditions of experiment were similar to the following:

The solution contained 0·1903 gram of mercury, 0·1200 gram of tin, and 30 cc. of sodium sulphide. The total dilution was 125 cc. The current gave 2 cc. of OH gas per minute, and acted for twelve hours. The precipitated mercury weighed 0·1909 gram.

The filtrates from the mercury deposits did not show even traces of this metal when they were examined.

CHEMICAL LABORATORY OF THE UNIV. OF PA.,
PHILADELPHIA, February 13, 1891.

THE ELECTROLYTIC DETERMINATION OF GOLD.

BY EDGAR F. SMITH.

[*Read at the stated meeting, held February 17, 1891.*]

Gold has been estimated electrolytically in solutions, containing it as a double cyanide, or in the presence of sodium phosphate and phosphoric acid. From recent experiments I am satisfied it can be determined in the same manner by the decomposition of solutions of sodium sulphaurate.

Years ago Parodi and Mascazzini (*Zeit. f. Analyt. Chemie*, **18**, 588), showed that antimony was completely precipitated from solutions of its ammonium sulpho-salt by the electric current. Classen elaborated this idea (*Ber.* **14**, 1622; **17**, 2467; **17**, 2245; **18**, 1110), substituting sodium sulphide for ammonium sulphide, and succeeded in effecting a most excellent separation of antimony from both tin and arsenic.

The sodium sulphide, used in the experiments recorded in this communication, was prepared by supersaturating a definite volume of caustic soda (1·3 sp. gr.) with hydrogen sulphide gas. An equal amount of caustic soda was then added, and the current of hydrogen sulphide continued for some hours through the solution. The liquid was then rapidly concentrated, until a crystalline scum appeared upon its surface. In this condition it was placed in bottles provided with tight-fitting corks. Crystals separated as the liquid cooled. These were recrystallized, and then dissolved for use. The specific gravity of their solution equalled 1·1800.

Experiments.—(1) To a chloride solution of gold containing 0·1446 gram of metallic gold, were added 10 cc. of sodium sulphide (Na_2S), and 100 cc. of water. The electric current, allowed to act upon this mixture, gave 2·6 cc. OH gas per minute. The time of precipitation extended through the night.

The deposit of metallic gold weighed 0·1446 gram. It was bright yellow in color, and very adherent. Water alone was used to wash it. The drying was done upon a warm iron plate.

(2) In this experiment the same quantity of gold was present as in the first trial. The volume of sodium sulphide did not exceed 20 cc., while the total dilution of the electrolyte was 100 cc. The current gave 2·6 cc. OH gas per minute. The metallic deposit was bright in appearance, firm and adherent. It weighed 0·1446 gram. The precipitation was complete in five and one-half hours.

The depositions of metal were made directly upon platinum. The gold was removed by covering it with a dilute solution of potassium cyanide, allowing the latter to remain for several hours in the dishes. When desired, the gold deposit can be very speedily removed by connecting the dish with the anode of a battery, and employing a platinum rod, which dips into the solution, as cathode. Platinum will not dissolve if feeble currents are used.

The results, given above, leave no doubt as to the applicability of this method in the estimation of gold.

Subsequent efforts were directed to its separation from other metals. As antimony can be deposited from a sodium sulphide solution by a current giving 1·5–2·0 cc. of OH gas per minute, I made no attempt to separate it from gold. The separation of gold from tin was much desired. Numerous trials were made. The results, however, were unsatisfactory. The gold was, in all instances, precipitated, but it carried down with it from one to three per cent. of tin.

The sodium sulphide, in these separations, showed a specific gravity of 1·21. An additional gram of sodium hydroxide was introduced into the electrolyte for every centigram of metallic tin present. The current did not exceed 1·5 cc. of OH gas per minute. The dilution with water was 100 cc. While these conditions were exactly analogous to those in which antimony is separated from tin, they failed in the case of gold and tin.

Gold from Arsenic.—(1) The solution electrolyzed contained 0·1446 gram of gold, as chloride, 20 cc. of sodium arsenate solution (= 0·15920 gr. metallic arsenic), 60 cc. sodium sulphide, and 100 cc. of water. The current gave 1·2 cc. OH gas per minute. It ran through the night. The washed and dried deposit of gold weighed 0·1443 gram.

(2) With conditions similar to those in (1) the gold weighed 0·1446 gram.

Gold from Molybdenum.—(1) 0·1437 gram of gold, as chloride, 0·1500 gram molybdenum, as ammonium molybdate, 40 cc. of sodium sulphide, and 120 cc. water were exposed to the influence of a current giving 0·7 cc. OH gas per minute. The time of deposition was twelve hours. The gold weighed 0·1430 gram.

(2) 0·1178 gram of gold, as chloride, 0·1200 gr. of molybdenum, 30 cc. of sodium sulphide (sp. gr. 1·12), and 100 cc. of water were electrolyzed with a current giving 2 cc. OH gas per minute.

The precipitated gold weighed 0·1172 gram. The current acted ten hours.

Gold from Tungsten.—(1) 0·1437 gram of metallic gold, as chloride, 0·1500 gram of tungsten, as ammonium tungstate, 20 cc. sodium sulphide (sp. gr. 1·17), and 100 cc. of water, gave 0·1440 gram gold, when electrolyzed with a current generating 1 cc. of OH gas per minute. The precipitation required twelve hours.

(2) In this trial 0·1440 gram of gold was found. The conditions were analogous to those of (1).

The gold deposits in all of the separations were bright and compact. The same manner of washing and drying was pursued as in the first determination of the metal.

Gold was never discovered in the liquid removed from the deposit.

Qualitative trials proved that the separation of gold from vanadium, under conditions similar to those already mentioned, was also possible.

CHEMICAL LABORATORY OF THE UNIV. OF PA.,
PHILADELPHIA, February 13, 1891.

PROCEEDINGS.

[*Stated meeting, held at the Institute, Tuesday, April 21, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, April 21, 1891.

Dr. WM. H. WAHL, President, in the chair.

Twenty-two members and three visitors were present.

Mr. Geo. M. Beringer was proposed for membership, and at the close of the meeting he was elected a member of the Section by the committee on admissions.

Prof. Joseph W. Richards read a highly interesting paper, entitled "On the Heats of Formation of Metallic Fluorides." It was referred for publication.

Mr. Reuben Haines followed with a paper, entitled "On the Ammonia Process in Water Analysis;" this was also referred for publication.

Mr. Haines presented another paper giving the results of an analysis of an artesian well water from Germantown; it was read by title and referred for publication.

Mr. Fred. E. Ives called the attention of the Section to a letter from Prof. Chas. F. Himes, discussing the experimental results and the theoretical explanation of Prof. Lippmann in the matter of photographing in colors. He also read a portion of a paper recently published by Capt. Abney, and bearing on the same subject.

Dr. Wahl, on behalf of Mr. John Carbutt, presented a communication on the "Diazotype Process of Photographic Dyeing and Printing." Several highly satisfactory specimens of results accomplished with this process were submitted for inspection by the members; they were regarded with much interest.

The Section then adjourned. WM. C. DAY, *Secretary*.

ON LOCAL STANDARDS IN WATER ANALYSIS WITH SPECIAL REFERENCE TO PHILADELPHIA AND ITS VICINITY.

By REUBEN HAINES.

[*Read at stated meeting of the Section, held February 17, 1891.*]

One of the difficulties presented in the "Analysis of potable water" is the obtaining of a suitable standard with which to compare the results of analysis of any given water, in order to form a correct judgment of its character for drinking purposes.

A general standard, such as is given in some published works on this subject, is found in many cases inapplicable or misleading. Special local standards are therefore advised for each locality. These may be obtained by collecting a considerable number of analyses of such well and spring waters of a given district as are, as far as possible, in a natural uncontaminated condition, and an average derived from these may form a standard of purity, to which a potable water should conform quite closely.

It is true, however, that one should not apply such a standard as a "hard and fast rule" to *all* waters in the particular locality for which the standard is devised. Different classes of waters should be judged by separate standards and the results of analyses of waters of different classes should be tabulated separately. Thus river waters should not be compared with well waters. They should be judged by somewhat different standards. Lake or pond waters may be judged by river-water standards under ordinary conditions of location and surrounding drainage area. Well waters, located within the same geological district, may be compared with each other. Yet the writer fully coincides with the statement of the late Prof. Wm. R. Nichols that "there always will be difficulty in deciding how near to any limit any suspicious water may come and still be used with a reasonable degree of safety;" and that "every doubtful water must be considered by itself with all the light that can be brought to bear upon it."* Strictly speaking, a pure drinking water should be only one which is altogether above *any* suspicion of contamination with sewage or other injurious substances. But, it may not be practicable to obtain such absolutely pure natural water in some localities, as, for instance, in a village having no public supply. The question then arises, what constitutes a reasonably pure water under the special circumstances, and to what degree may the evidence of slight contamination through the occupations of man or beast be disregarded without risk of imperilling the health in any way, either at the present time or in the somewhat undefined future; for what may be safe now may not be quite safe a year hence. It is, therefore, highly desirable to become thoroughly acquainted with the locality, by personal inspection of the premises, and to confirm or modify the opinion derived from analysis by the facts observed. In many cases it is difficult, and in some impossible, to form any correct judgment at all without examination of the immediate vicinity of the well. It will not do, in all cases, to depend upon getting the desired information at second hand by correspondence or otherwise.

Nevertheless, a standard of some kind is desirable, in order to secure as much uniformity of practice as possible, and it will be found helpful to have special standards of the kind proposed.

In using such a standard it should be remembered, also, that the judgment is formed partly from the ratio one "element," so to speak, in the analysis bears to another, and partly from the consensus of all the facts, including some which may not be capable of being tabulated in the report.

Knowing of no published standard for well and spring water of the vicinity of Philadelphia, the writer ventures to give the results of some analyses which he has made, during the past fourteen years, of waters of this class, which he believes both from analysis and from personal inspection of the premises, to be entirely pure and uncontaminated. He submits them as a contribution towards a definite standard for the vicinity of Philadelphia, on the Pennsylvania side of the Delaware River, with the hope that other chemists practically interested in this subject may likewise add the results of their experience, as the writer believes the aggregate number of analyses presented in this paper is too small to establish definitely the proposed standard for such a large area as these cover.

---

* "Water Supply—Chemical and Sanitary," Wm. Ripley Nichols, p. 40–41.

It should be further stated that in many of the following analyses other determinations were made, such as oxygen required to oxidize organic matter by potassium permanganate in place of sulphuric acid. As, however, at first, the Tidy form of this process and later the Kabel method, as modified by Leeds were used, the results of which processes are different and not comparable with each other, all results by the permanganate process have been omitted from the following tabular statement. It is desirable that in subsequent work this determination should be included.

The nitrogen as nitrates was in the earlier analyses determined by Williams' copper-zinc couple method, and in the latter ones by the phenol sulphonic acid method. I obtained excellent results in test analyses by the Williams method with solutions of potassium nitrate, provided the amount of the nitric acid in the solution was not very greatly in excess of the amounts usually found in highly contaminated drinking waters. In the presence of very large amounts of "free ammonia" in well waters, it is often almost impossible to get constant results, but in these cases the quantitative determination may safely be omitted as unnecessary for the purpose of sanitary judgment of the water; a qualitative test would, in that case, usually be quite sufficient. Yet in some cases much free ammonia may be accompanied by but little nitrate. The phenol sulphonic acid method was also tested against the Williams method and a known solution of nitrate, in my laboratory, and these two methods were found to give essentially identical results. There appears, however, according to Mr.

Bartram, to be some reason for questioning the accuracy of the phenol sulphonic acid method in presence of much chloride.

Neither of these methods, nor indeed, any colorimetric test is suitable for solutions containing comparatively very large percentage of nitric acid, such as organic liquids rich in nitrates.

In a number of the earlier analyses, a simple qualitative test for nitric acid was thought sufficient. The test used was the well known ferrous sulphate solution, with equal volumes of pure concentrated sulphuric acid and the water to be examined. This qualitative method was used by Prof. Nichols in his analytical work for the Massachusetts State Board of Health. Tests by the present writer with this solution showed that with careful manipulation it would indicate clearly about one part of nitrogen as nitric acid in 100,000 parts of water, and that it would show a faint reaction with 0·7 to 0·8 parts per 100,000. The test cannot be made a quantitative one, however, except in the sense above indicated. By concentration of the water by evaporation, one can secure a more distinct reaction, but it is very difficult at least, if not impossible, to get the depth of tint to follow exactly in accordance with the degree of concentration of the water, even when closely adhering to an identical mode of manipulation. The sulphuric acid used was always, of course, examined for nitric acid, and rejected if its presence was shown by this test.

Equal measured quantities of the acid and the water to be examined about 5 cc. of each were put into a test tube; the water first and the acid poured in gradually along the sides of the *inclined* test-tube so as to form a layer at the bottom without mixing much with the water. After cooling, a few drops of concentrated ferrous sulphate solution were added and the tube again plunged in cold water. If a colored ring formed at the junction of the acid and water, after slight agitation, the water was considered suspicious of contamination with sewage. If the ring of color was formed immediately and of strong tint, it indicated *dangerous* contamination, and the water was generally found to be foul in respect to the other parts of the analysis. There are some cases, however, occurring occasionally in which the judgment rendered must be based *chiefly* upon the amount of nitrates present. It is, therefore, better to use a method which can be made quantitative.

In the following tables an *asterisk* (*) in the column of nitrogen as nitrates indicates that by the ferrous sulphate test either there was no reaction or only the faintest coloration after standing for about half an hour, showing less than one part of nitrogen as nitrate for 100,000 without any concentration of the sample.

The following are the tabulated results of analyses alluded to above, arranged according to the several districts included. All numerical results are stated in parts per 100,000.

GERMANTOWN.

No.	Description, Location, etc.	Date.	Free NH_3	Alt. NH_3	Cl.	Nitr'g'n in Nitrates	Total Solids.
1	Haines St. E. of Chew St. Well, ...	1877	·0014	·0034	1·00	—	—
2	“ “ “ “	1883	·0040	·0040	·80	*	—
3	“ “ “ “	1886	none	·0036	1·80	·247	11·0
4	“ “ “ Spring, . . .	1877	·0012	·0030	—	—	—
5	“ “ “ same “	1884	·0012	·0034	1·00	*	—
6	“ “ “ “ “	1889	·0010	·0052	·80	—	10·5
7	“ “ “ “ “	1889	none	·0030	·80	*	—
8	High Street Well, ...	1877	·0026	·0064	1·40	*	5·0
9	Mill Street, E. of Willow, Well, ...	1880	·0022	·0062	1·80	*	22·8
10	Clapier Street Spring, ...	1889	·0010	·0052	1·60	·720	13·0
11	West Chelten Avenue Well, ...	1877	·0040	·0052	1·00	*	8·5
12	Wayne Junction Well, ...	1882	·0026	·0050	1·80	·520	—
	Average, ...	—	·0018	·0045	1·15	·495	11·8

VICINITY OF FRANKFORD.

13	Well, ...	1886	·0040	·0030	1·10	·741	10·5
14	Spring in Woods, ...	1888	none	·0030	.80	·257	9·0
	Average, ...	—	·0020	·0030	·95	·499	9·7

BRANCHTOWN TO CHELTEN HILLS.

No.	Description, Location, etc.	Date.	Free NH_3	Alt. NH_3	Cl.	Nitr'g'n in Nitrates	Total Solids.
15	York Road Well, ...	1890	none	·0040	1·20	·150	10·0
16	" "	1881	·0010	·0040	2·00	*	7·5
17	Washington Lane Well, ...	1886	·0010	·0050	1·00	·412	10·5
18	" " same Well, ...	1889	none	·0050	·80	·370	9·0
	Average, ...	—	·0005	·0045	1·25	·311	9·2

HAVERFORD AND BRYN MAWR.

19	Vicinity of Hav. College Well, ...	1880	·0010	·0056	1·10	*	12·9
20	" " "	1889	·0048	·0046	·70	·600	9·0
21	" " Spring, ...	1891	·0020	·0070	1·00	·750	11·5
22	Bryn Mawr Spring, ...	1880	·0022	·0070	·70	*	5·7
23	" same Spring, ...	1881	·0010	·0030	·70	*	5·0
24	" "	1883	·0026	·0066	·60	·263	4·5
25	" Well, ...	1880	·0040	·0050	1·10	*	10·0
26	" "	1883	·0010	·0038	1·20	·347	8·5
27	" "	1888	·0026	·0030	·70	·412	7·4
	Average, ...	—	·0023	·0051	·87	·474	8·3

OVERBROOK.

28	East of Penna. R. R. Well, ...	1882	·0046	·0040	1·45	*	12·0
29	West of " " Spring, ...	1887	·0040	·0030	·70	·249	10·5
	Average, ...	—	·0043	·0035	1·07	·249	11·2

SPRING MILL NEAR CONSHOHOCKEN.

30	Public Spring, hardness 12°·2, ...	1889	·0040	·0050	·50	·370	16·5

ARTESIAN WELLS.

31	Germantown, 312 feet deep, rock struck 8 ft. from surface, ...	1877	·0020	·0040	3·00	*	30·0
32	Columbia Ave. near Broad St., ...	1886	·0160	·0030	1·50	·135	28·0
33	North Penn. R. R. near City, ...	1890	·0044	·0030	1·10	·100	15·0
34	Vicinity of Darby, Delaware Co., Pa., .	1889	·0010	·0050	1·10	·470	—

It is thought proper to place the above artesian wells in a separate class by themselves, and they are not therefore included in the following computation of averages for the above tabular statements. The artesian wells show plainly the degree of purity obtainable by them. Numbers 32, 33 and 34 are 100 feet in depth, or but slightly more than that. In No. 31 the water rises to about thirteen feet from the surface, and an iron tube extends nearly the whole distance through rather soft rock. Since the above analysis it has become impure, and is seldom used for steam purposes.

The following are the averages of the total figures in the above thirty analyses of shallow well waters, these being calculated only from the actual numerical results in each column, the qualitative tests as well as the blanks being omitted in the computation.

	Parts in 100,000.
Free ammonia,	·0020
Albuminoid ammonia,	·0045
Chlorine,	1·07
Nitrogen in nitrates,	·427
Total solids at 100° C.,	9·60

I ought to say that the figure for nitrogen as nitrates is not quite satisfactory, for it represents only one-half of the whole number of analyses, and assumes that the other half if determined quantitatively would yield about the same average which may not be strictly correct.

The determination of total solids is of not much importance, and is of use chiefly in this connection to show the general character of the water as regards hardness. It is to be noted that most of these well waters are quite soft. In hard sulphate waters the natural amount of chlorine appears to be higher (about double) than in softer waters. In the usual course of analysis the determination of total solids gives useful information in several ways.

In conclusion, the above average results is submitted as an approximate standard for the purest available shallow well waters of this district to be corrected by additional analyses.

As a necessary part of this work it is highly desirable to obtain figures representing the *highest limits* for waters of this class under *specified conditions.* This will be more difficult to fix definitely, for a certain latitude must always be permitted to satisfy special conditions. This limit will certainly be different for different sections of the country. I think, however, that for the vicinity of Philadelphia on the Pennsylvania side of the Delaware River the figures for free and albuminoid ammonia will be found closely to approximate those given by Wanklyn in his book on water analysis. In certain parts of New Jersey, for instance, the limit is probably higher.

"ON A SOURCE OF ERROR IN THE DETERMINATION OF NITRATES IN WATER BY THE PHENOL SULPHONIC ACID METHOD."

By George H. Bartram.

[*Read at the stated meeting of the Chemical Section, March 17, 1891.*]

Owing to certain discrepancies in duplicate estimations of nitrates, by the phenol sulphonic acid process, I was requested by Dr. Samuel C. Hooker to make a series of experiments to ascertain under what conditions this process, which had hitherto been considered reliable, gave these varying results. The work was performed in Dr. Hooker's laboratory and under his direction.

As the principal result of these experiments it was found that phenol sulphonic acid undergoes a change shortly after preparation, as shown by the fact that chlorides, which have no effect on the determinations when made with freshly prepared phenol sulphonic acid, bring about low figures when the acid has been kept for some time before use.

The disturbing action of the chlorine is already well marked, when the quantity present in a given volume of water is about four times as great as the nitrogen of the nitrates. Correct figures were, however, obtained even when the phenol sulphonic acid had been kept eighteen months, with water in which the chlorine did not much exceed the nitrogen of the nitrates. Water containing twenty parts chlorine to ·5 parts nitrogen gave the following decreasing quantities of N as the age of the solution increased:

N. present.	*N. found.*	*Age of phenol sulphonic acid.*
·5	·5	Freshly prepared.
·5	·5	1 day old.
·5	·45	2 days "
·5	·42	13 " "
·5	·40	17 " "
·5	·40	27 " "

Water containing ten parts chlorine to ·5 parts nitrogen gave a similar series of figures:

N. present.	*N. found.*	*Age of phenol sulphonic acid.*
·5	·5	Freshly prepared.
·5	·5	2 days.
·5	·42	13 "
·5	·40	17 "

With water containing two parts chlorine to ·5 part nitrogen the results similarly fell off.

N. present.	*N. found.*	*Age of phenol sulphonic acid.*
·5	·50	Freshly prepared.
·5	·50	13 days.
·5	·40	27 "

The above determinations were made in duplicate and the standards were always freshly prepared.

A solution of phenol sulphonic acid two and a half months old gave, as the mean of four determinations, ·30 instead of ·5 N, in the water containing ten parts chlorine to ·5 N.

A solution eighteen months old also gave ·30 N for the same water.

By the removal of the chlorine correct results were obtained.

The above experiments show that in the presence of relatively large quantities of chlorine twenty per cent of the nitrates, or in extreme cases even as much as forty per cent. may fail to be recorded by the use of this process, unless the precaution be taken to use freshly prepared phenol sulphonic acid, or to remove the chlorine.

ANALYSIS OF A CHROMITE.

By H. Pemberton, Jr.

[*Read at the meeting of the Chemical Section, held March 17, 1891.*]

On the Pacific Coast of the United States there are several deposits of chromite. As no complete analysis of any of these minerals has, to my knowledge, been published, it may be of interest to place on record an analysis I made some time ago.

According to Wm. Irelan, Jr., State Mineralogist of California, throughout the Santa Lucia Mountains and the coast hills of San Luis Obispo County, Cal., are found serpentine rocks with beds of chromite, in greater or less masses existing as loose and fragmentary rocks in the ravines and on the hillsides, and as pockets and veins on the mountains. One of the best mines of the neighborhood is the Pick and Shovel, located on the South Fork of Chorro Creek, at an elevation of 1,800 feet.

A sample of the chromite from this mine, selected as free from gangue as possible, gave on analysis the following results:

Cr_2O_3,	52·68
Al_2O_3,	11·40
Fe_2O_3,	3·52
MgO,	16·23
FeO,	11·77
MnO,	0·15
SiO_2,	3·40
H_2O,	0·94
	100·09

An analysis of the gangue showed it to be serpentine, containing a trace only of ferrous oxide. No other foreign mineral could be detected on a careful examination. Deducting, therefore, the water, silica, and quantity of magnesia (3·26 per cent.) combined with the silica (as serpentine) and calculating the remainder to 100 parts, we obtain for the pure mineral:

Cr_2O3,	56·96	·374	= ·519
Al_2O3.	12·32	·121	
Fe_2O3.	3·81	·024	
MgO.	14·02	·350	= ·529
FeO,	12·73	·177	
MnO,	0·16	·002	
	100·00		

R2O3 : RO = 519 : 529 = 1·00 : 1·02.

The mineral was decomposed by fusion with sodium carbonate. (Christomanos' process slightly modified.) The mixture of ore and Na_2CO_3 is heated over night by a Bunsen burner, the crucible being loosely covered by its lid. Next morning it is heated for one hour over the blast lamp, with frequent stirring. The process has the advantage of giving complete decomposition of the mineral, with the introduction of no bases other than the alkalies.

The ferrous oxide was determined by solution in sulphuric acid in a closed tube, under pressure. According to Francis C. Phillips (*Fres. Zeitschrift*, **12**, 189) 1·34 is the specific gravity of the acid that is most favorable to the solution of chromite in this manner.

AN APPARATUS FOR HEATING SUBSTANCES IN GLASS TUBES UNDER PRESSURE.

By H. Pemberton, Jr.

[*Read at the meeting of the Chemical Section, held March 17, 1891.*]

Chemists who do not happen to have in their laboratories oil or air baths for heating closed tubes, can make an air bath at short notice, from materials furnished by all dealers in steam fittings.

Order :

(1) One four-inch wrought-iron pipe, eighteen inches out to out, with usual thread on each end. At about nine

inches from either end this pipe is drilled and tapped for a one-inch nipple, in such a manner that a pipe introduced would pass, not on a line with the radius, but about half-way between the axis of the four-inch pipe and its walls; in other words, it would be on a line with a chord of the circle.

(2) One one-inch wrought-iron nipple, two inches long, one-inch thread on one end.

(3) Two four-inch malleable iron caps, drilled and tapped for a one-inch pipe.

(4) One one-inch wrought-iron pipe, twenty-four inches out to out, with a three-inch straight thread on each end.

(5) Two one-inch iron caps. A hole, one-eighth of an inch in diameter, is drilled in the end of one of these caps.

The above order can be given *literatim*, and will be understood by the dealer, who will furnish, at a trifling cost, the materials, cut and tapped as ordered.

Fig. 1 shows how the whole is put together. The numbers on the figure correspond also to the numbers of the paragraphs of the order as given above.

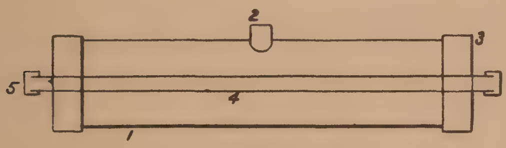


FIG. 1.

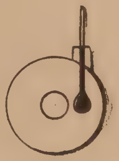


FIG. 2.

Fig. 2 is an end section. A cork is inserted in *2* and through it a thermometer, the bulb of which is on a level with the interior pipe. The whole is supported on a few bricks at either end, and is kept steady and in place by a couple of weights or half bricks. It is heated by one or two Bunsen burners, according to the temperature desired.

PROCEEDINGS.

[*Proceedings of the stated meeting, held Tuesday, May 19, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 19, 1891.

Dr. WM. H. GREENE, Vice-President, in the chair.

Sixteen members and seven visitors were present.

Dr. W. P. Mason, of the Rensselaer Polytechnic Institute, of Troy, N. Y., read a paper on, "Drinking Water and Disease." It was referred for publication. A discussion of the paper, which was of much interest, followed, and was conducted by the author and Messrs. Pemberton, Jayne and Haines.

Mr. Pemberton called attention to the conditions of the water supply of Chester and discussed the effect of Philadelphia sewage upon it.

Dr. Bruno Terne presented a paper on "Meat Preservatives," giving a discussion of the ingredients and their effects upon the human system when present in meat used as food.

The paper was discussed by the author and Mr. Haines.

Adjourned. WM. C. DAY, *Secretary.*

ON THE AMMONIA PROCESS OF WATER ANALYSIS.

BY REUBEN HAINES.

[*Read at the stated meeting, held April 21, 1891.*]

Two forms of this process are in use, one dealing with a half litre or a full litre of the water; the other requiring only 100 cc. for the distillation. The writer prefers the former, although some chemists find the latter fully as accurate and more convenient.

The following notes indicate the practice of the writer for a number of years, in addition to the instructions given by Wanklyn.

The amount of sample used is one-half litre, or, in some very impure waters, a less quantity of the sample diluted to half a litre with pure distilled water.

The retort is of large size, having a capacity of from one-third to one-half gallon when completely filled, and is supported at the neck by a large retort-clamp upon a heavy iron stand. It should not be supported on a ring, unless wire gauze be interposed, as otherwise there is great danger of fracture of the retort. If a Bunsen burner with wire gauze is used close up beneath the retort with such a body of liquid there is still danger of fracture.

The neck of the retort is inclined *upward* at an angle of about 25° and attached to a Liebig condenser having an inner tube of one inch diameter, by a short piece of wide rubber-tubing in such manner that the ends of the retort and condenser are in close contact and that as little rubber as possible is exposed to the action of the hot vapor. In lieu of this arrangement a few inches of the end of the retort-neck may be bent downward parallel with the condenser, and be made to enter loosely within the glass condenser tube; a short piece of rubber-tubing overlapping the connection. In either case, the rubber should be tied down to prevent leakage, but in such manner that the retort may readily be disconnected at the conclusion of the analysis. The rubber will have to be renewed after a time. The mode of connection recommended by Wanklyn has been shown by Dr. Smart, Mallet and others, to permit loss of ammonia by leakage.

A rather rapid current of water should be maintained in the Liebig condenser. If this condenser alone is used, the current should be so rapid that the temperature of the water at the exit is not materially raised by the operation if the water used has an original temperature of from 50° to 60° F. If the water is of higher temperature than this ice should be used for cooling it. A better plan is that adopted by the writer, which consists in attaching the lower end of the Liebig condenser as closely as possible to a glass vertical coil condenser of the Mohr pattern, of which the outer vessel is an inverted jar receiver (a large inverted bottle with the bottom cut off will do very well), into which broken ice may be placed, especially in hot weather. The glass tube forming the coil has an inside diameter of about half an inch. Beneath this second condenser a short nearly horizontal tube, conducts the distillate to the Nessler glass out of reach of contaminating dust, etc., that might chance to fall from the vertical condenser.

By having the retort sufficiently large, and by inclining its neck upward all danger of the permanganate being thrown over into the condenser is avoided. Risk of fracture is greatly lessened by the use of the retort clamp, and by the rod of the stand acting as a sort of spring to moderate the shock of bumping, and the retort may thus last in frequent use for a very long time. One of mine lasted several years, but it became unavoidably weakened in time by the corrosive action of the boiling alkaline liquid. By the above-described arrangement of the condensing apparatus, the distillate may be obtained at a given uniform temperature in all analyses in order to get uniform depths of color in the Nessler testing, a precaution to which some one has called attention. The risk of loss by imperfect condensation of ammonia during regular distillation, or through the outrush of gusts of vapor produced by turbulent boiling is also avoided. The condensing tube should, on account of this latter circumstance, be of comparatively large diameter throughout its whole length. With the above arrangement I have not found any loss by imperfect condensation, if the temperature of the distillates did not exceed 60° F. If a lower temperature than this is adopted, the distillates should be allowed to stand until they acquire a uniform temperature before applying the Nessler test.

The arrangement I have adopted was suggested by reading the *Report on Water Analysis*, by Prof. Mallet, to the National Board of Health, 1882, in which this loss of ammonia occurring when Wanklyn's instructions are followed is referred to, and a somewhat different arrangement suggested for avoiding it. In experiments with a known solution of ammonium chloride this loss was found by Dr. Smart to amount to an average of about seven per cent. of the whole amount that should have been obtained. It should, however, be noted that Mallet states that "the temperature of the condensing water varied from 25° to 25°·5 C."

which is a rather high temperature. In these experiments the current of water in the condenser was so rapid that its temperature was not sensibly raised by the process, even when fifty cc. of distillate were obtained in eight minutes. The distillates of fifty cc. each are received directly into the Nessler tubes marked at fifty cc., and the earlier portions may be Nesslerized while the distillation is progressing. Wanklyn advises to Nesslerize only the first distillate of fifty cc. free NH_3 and add to this one-third. In waters containing enormous amounts of free ammonia, however, it is better either to distil the whole of the free ammonia into a flask in one portion, dilute, and take an aliquot part for the Nessler test, or to follow Dr. Smart's plan of Nesslerizing each successive distillate of fifty cc., previously diluting if necessary. Dr. Smart believes that the presence of urea in the water may be detected by peculiarities in the manner in which the free ammonia distils over in the successive portions. I have found that polluted waters containing enormous amounts of free ammonia such as to give a very deep color or a precipitate by the Nessler test in fifty cc. of the original sample appear to yield four-fifths or five-sixths of the whole amount in the first portion of fifty cc. instead of three-fourths, as stated by Wanklyn.

It is not advisable to put anything whatever, such as pieces of ignited pumice, tobacco pipe, etc., inside the retort to moderate the bumping, as suggested by some, there being too much danger of introducing thereby organic or ammoniacal impurity. The bumping can be controlled if necessary by lowering the flame and by tapping gently on the retort so as to produce a concentric wavy motion on the surface of the liquid, which will cause the steam to rise more regularly and in smaller bubbles. A Bunsen burner, giving a large flame, should be used. I prefer one having several jets, or a rose-burner, and place it quite close to the retort, without any intervening wire gauze.

All the apparatus used for water analysis should be set aside exclusively for this purpose. Thorough washing of each article immediately before use is very essential. To be thought "clean enough" is by no means sufficient. The whole condensing apparatus set up ready for use, but disconnected from the retort, can be satisfactorily washed by flushing it thoroughly two or three times with clean hydrant water, closing the outlet by the finger or a clean cork until the condenser tube is full and then allowing the water to run out. This method of washing is much better than distilling some clean water through it as advised by some. The retort should be rinsed with a little concentrated sulphuric acid and washed thoroughly with clean tap water, and then immediately connected with the condenser.

The above form of apparatus may be considered by some to be cumbrous and to occupy too much space, yet I think it possesses certain real advantages which offset these objections.

The alkaline permanganate solution can readily be prepared so pure that one litre of it undiluted yields by distillation not more than 0·005 milligrammes NH_3 and that no more ammonia develops in it afterward if properly protected. I have been using for more than ten years solutions prepared to this degree of purity, made up in quantities of one litre, which have kept well. The preparation is accomplished by using only very good distilled water for making up the solution, and by not permitting the sticks of caustic potash (ordinary white sticks) to come in contact with any kind of organic substance in handling and weighing it out. The mixed solution is diluted to one and one-half litres and distilled in a large retort, slowly, until about 900 cc. remain, and then 50 cc. are tested with Nessler solution. If pure, the solution is transferred when cold to a litre flask and made up to the mark with perfectly pure distilled water, made free from ammonia and organic matter by distillation with some solution of alkaline permanganate of potash. I found that if river water from a hydrant was used in making the solution it was very difficult to obtain a solution perfectly free from ammonia, even after very protracted slow boiling. If an impure solution is used, and a correction applied for the impurity it contains, it will be found that the results of analysis are thereby subjected to error. I strongly suspect that errors from that cause did occur in some of my earliest analyses many years ago. Liability to error from this cause has been noticed also by others. Wanklyn, I think, never applied a correction for impurity, but always prepared the solution free from NH_3, if I understand rightly a certain discussion which took place in the early history of the process. Yet Dr. Tidy, in 1879, declared the preparation of a solution of alkaline permanganate, free from ammonia, to be impossible, and said that he always had to make a correction for the ammonia he found it to contain. This was one of the several objections that were strongly urged against the ammonia process of analysis. On the other hand, Prof. Mallet states, in his Report to the National Board of Health, 1882, that Dr. Smart in the investigations for that report made up his solution with good distilled water, and after the requisite boiling "it gave no coloration with Nessler reagent in fifty cc. distilled off from one-half litre."

Care should always be taken to rinse off the stoppered mouth of the bottle containing the permanganate solution both immediately before and after use, notwithstanding it may have been carefully protected from laboratory vapors, etc.

The rate at which both the free and albuminoid ammonia is evolved often affords valuable information as to the character of the organic matter contained in the water, and therefore the details of the separate Nessler testings should be preserved for reference. If, as sometimes happens, a peculiar odor is noticeable in the free ammonia distillate it may be presumed to be due to the volatile organic matter which has passed over with the free ammonia, but which will probably not produce a reaction with the Nessler test solution and be lost to the analysis. In this case a second distillation with alkaline permanganate added at first should be made with a fresh portion of the sample, thus obtaining the total ammonia, the free and albuminoid coming over together. If the amount of total ammonia is sensibly larger than the sum of the free and albuminoid obtained in the first distillation, the difference may be assumed to be ammonia from volatile organic matter.

From my own experience during about eight years, in which I have very frequently repeated the distillaton in the above manner, I am led to believe that the occurrence of a volatile organic substance in well waters is at least a comparatively rare circumstance. The test is, however, a useful check upon the accuracy of the analysis. The same proportions should be adhered to in the second as in the first distillation as regards the alkaline permanganate and the quantity of water operated upon.

Prof. Remsen found, however, in 1881 a striking instance of the presence of volatile organic matter, which failed to be estimated by the ordinary method of procedure in his investigations into the Water Supply of Baltimore. Soon afterwards, Mr. Chas. W. Marsh, then at Princeton, published a paper, in the *Amer. Chem. Journal*, giving a number of instances of similar nature in well and cistern waters which he had examined. The possibility of this occurrence should therefore be recognized and provision made for the estimation of the volatile organic substance.

ANALYSIS OF AN ARTESIAN WELL WATER.

By Reuben Haines.

[*Read at the stated meeting, held April 21, 1891.*]

The well from which the water is derived, of which an analysis is here given, is situated in a closely built-up portion of Germantown. It was sunk in 1875 to the depth of 312 feet, mostly through soft rock which was probably a micaceous schist. I was informed that about half-way down a stratum was entered which carried large quantities of iron garnets, similar to those found in the surface rock and washings at Wayne Junction. At the bottom a cavity in the rock was apparently entered, for a portion of the drilling apparatus suddenly dropped, and, falling to one side, was lost and never recovered.

The rock was first struck at about eight feet from the surface of the ground. The water rose to a level of about thirteen feet below the surface, and the average flow by pumping has since been forty gallons per minute, without lowering the water level materially. A continuous tube of plain wrought iron, about six inches in diameter, extends to within a few feet of the bottom.

The water was stated to have been originally of satisfactory character for steam purposes, although hard and unsuited to some technical uses.

In 1877, the writer made an analysis for its potable qualities with the following results:

	Parts in 100,000.
Free ammonia, ...	0·0020
Albuminoid ammonia, ...	0·0040
Chlorine, ...	3·00
Total solid matter at 100° C., . . .	30·00
Total hardness, ...	16°·8 { parts $CaCO_3$ in 100,000 by soap test.
Nitrates, ...	traces.
Sulphates, ...	large amount.

The water has since that time deteriorated so much in quality that it is now seldom used, but pumped every few weeks only to keep it clear of sediment for use in case of fire. It has a strong corrosive action on the iron tube, so that after remaining in it for several weeks it becomes exceedingly thick and turbid with iron oxide. It was in this turbid condition when the writer took a sample for analysis a few months ago, and it was only partially cleared of sediment after pumping rapidly for more than an hour.

The following are the results of analysis for potability after the abundant iron oxide was allowed to settle out from which the water was decanted, but not filtered for the determination of the free and albuminoid ammonia. For the other parts of the analysis the water was filtered.

	Parts in 100,000.
Free ammonia, ...	0·0590
Albuminoid ammonia, ...	0·0060
Nitrogen in nitrates, ...	0·77
Chlorine, ...	3·10
Total solids dried at 120° C., ...	54.50
Mineral matter, ...	48·56
Organic and volatile matter by ignition, ...	5·94
Temporary hardness by Hehner's method, ...	10°·5 CaCO
Permanent " " " "	15°·0 "
Total " " " "	25°·5 "

The following are the results of analysis of the mineral ingredients:

	Parts in 100,000.	*Grains per U. S. Gal.*
Na_2O,	7·44	4·341
$(NH_4)_2O$,	09	·052
CaO,	7·32	4·269
MgO,	5·44	3·172
Fe_2O_3 and Al_2O_3,	·35	·204
SiO_2,	1·90	1·108
Cl,	3·10	1·808
SO_3,	16·86	9·832
N_2O_5,	2·97	1·732
CO_2 (calculated),	4·65	2·715
Organic matter, H_2O, etc., after deducting for loss of N_2O_5, CO_2, etc.,	5·01	2·922

These constituents are probably combined in the following manner:

	Parts in 100,000.	*Grains per U. S. Gal.*
Ammonium nitrate,	·180	·105
Sodium chloride,	5·100	2·974
Sodium nitrate,	4·533	2·643
Sodium sulphate,	7·081	4·129
Calcium sulphate,	17·777	10.367
Magnesium sulphate,	3·624	2·113
Magnesium carbonate,	8·887	5·183
Silica, ferric oxide, alumina,	2·250	1·312
Organic matter, water of hydration, etc.,	5·010	2·922
	54·442	31·748

The Na_2O was not estimated directly but calculated from the difference between the weighed solids converted into sulphates, and the CaO and MgO calculated as sulphate together with the SiO_2, Fe_2O_3 and Al_2O_3.

The test for hardness was made in the first analysis by the soap solution according to Clark, and in the recent analysis by Hehner's method which is much more accurate, especially in presence of magnesium salts.

The points of interest in regard to this well water are the increase of total solids and of hardness in a deep well water, and also the fact of its being so actively corrosive of iron in the cold.

SUPPLEMENT TO THE DETERMINATION OF THE HEAT OF EVAPORATION, ETC., OF LIQUID AMMONIA.*

BY DR. HANS VON STROMBECK.

[*Presented at the stated meeting of the Chemical Section, held Jan. 19, 1891.*]

In vol. cxxx, No. 780 (December, 1890), of this journal, I gave the figures and authentic proofs for the heat of evaporation, etc., of liquid ammonia. The latter agreed well enough with one another for the purpose for which those tests were made, "to prove once more that about 500 and not 900 English thermal units were the true figures for the latent heat of liquid ammonia," but they do not agree well enough if considered from the scientific point of view. I, therefore, determined the latent heat of liquid ammonia by another series of twelve tests, the results of which I give in the following:

I made the tests and the calculations in the same manner as described in the number of this paper above-mentioned, but made the following alterations:

I *weighed* the water filled into the calorimeters instead of *measuring* it.

I placed each calorimeter in a box by itself, so that they were separated by a narrow stratum (about one-half inch) of external air. By this I intended to lessen the influence of the first calorimeter on the second one, but the figures afterwards showed that this intention was fulfilled to but a limited extent.

I took as much ammonia as with safety could be put in tank *IKL*, and I made the first calorimeter *ABCD* smaller, so as to have to take less water.

I placed two thermometers in the first calorimeter, one reading from 28 to 18°, the other from 20 to 11°.

I placed an agitator in the second calorimeter. Though this makes the handling of the apparatus still more complicated, the agitator cannot be dispensed with, as only in this manner the true figures of the temperature prevailing in the second calorimeter can be obtained.

---

* From the laboratory of the De La Vergne Refrigerating Machine Co.

I determined the influence of the external surroundings in another manner from that of the former tests. In those, I followed the method used by Regnault, which requires the simultaneous reading of three thermometers at the end of every minute. In order to be made exact, these readings require three skilled observers, whom I had not at my disposal when I made the former tests, nor at present, and I attribute the discrepancy of the figures of my former tests mostly to my having been compelled to have the readings of two thermometers made by unskilled persons. I, therefore, determined the external influence this time in the following manner, which, theoretically, is not quite as exact as the one used by Regnault, but the errors of which are within the limit of the inevitable errors of observation, as I shall show by two examples, which follow.

DETERMINATION OF THE INFLUENCE OF THE EXTERNAL SURROUNDINGS ON THE TEMPERATURE OF THE CALORIMETERS.

I shall add to each item the figure obtained in the first test. As soon as, at the end of the test, the thermometer in the first calorimeter stops going down, the time m (42′) elapsed since the commencement of the test and the temperatures indicated by the thermometer in the first calorimeter T_m (14°·79), by the thermometer in the second calorimeter τ_m (22°·75), by the thermometer in the air ϑ_m (21°·10), are noted down. After n minutes (10′) have elapsed, the temperatures indicated by the three thermometers T_n (14°·96), τ_n (22°·38) ϑ_n (21°·06) are again noted down. From these figures the heating or cooling effect of the external surroundings on the first calorimeter δ (— 0°·221) and on the second calorimeter δ_1 (0°·963) can be calculated.

(1) δ: The temperature of the first calorimeter is influenced by the temperature of the air and by that of the second calorimeter. But we may neglect the influence of the latter, its temperature being only little different from

the temperature of the air. During the *n* minutes (10′) the first calorimeter was heated up by $T_m - T_n$ degrees ($-0^\circ\cdot17$), the difference between the average temperature of the first calorimeter

$$\frac{T_m + T_n}{2} \ (14^\circ\cdot88)$$

and the average temperature of the air

$$\frac{\vartheta_m + \vartheta_n}{2} \ (21^\circ\cdot08)$$

being $-6^\circ\cdot20$. During the *m* minutes (42′) the difference between the average temperature of the first calorimeter

$$\frac{T + T_m}{2} \ (19^\circ\cdot595)$$

and the average temperature of the air

$$\frac{\vartheta + \vartheta_m}{2} \ (21^\circ\cdot52)$$

having been only $-1^\circ\cdot925$, we obtain:

$$\delta = \frac{(-0\cdot17)\,.\,42\,.\,(-1\cdot925)}{10\,.\,(-6\cdot20)} = -0^\circ\cdot221.$$

(2) δ_1: The temperature of the second calorimeter is influenced by the temperature of the air and that of the first calorimeter. During the *n* minutes (10′) the second calorimeter was cooled down by $\tau_m - \tau_n$ degrees ($0^\circ\cdot37$), its average temperature being

$$\frac{\tau_m + \tau_n}{2} \ (22^\circ\cdot565).$$

As the average temperature of the external surroundings is expressed by the average of the mean temperatures of the first calorimeter and of the air, *i. e.*, by

$$\tfrac{1}{2}\left[\frac{T_m + T_n}{2} + \frac{\vartheta_m + \vartheta_n}{2}\right] = 17^\circ\cdot98,$$

the difference prevailing during the *n* minutes is $22\cdot565 - 17\cdot98 = 4^\circ\cdot585$. During the *m* minutes (42′) the difference between the average temperature of the second calorimeter

$$\frac{\tau + \tau_m}{2} \ (23^\circ{\cdot}40)$$

and the average temperature of the external surroundings

$$\tfrac{1}{2}\left[\frac{T + T_m}{2} + \frac{\vartheta + \vartheta_m}{2}\right] = 20{\cdot}558$$

having been only $23{\cdot}40 - 20{\cdot}558 = 2^\circ{\cdot}842$, we obtain

$$\delta_1 = \frac{0{\cdot}37 \,.\, 42 \,.\, 2^\circ{\cdot}842}{10 \,.\, 4{\cdot}585} = 0^\circ{\cdot}963.$$

To make sure that the value obtained for δ_1 was the true expression for the external influence on the second calorimeter, I placed the first calorimeter *ABCD* with its appurtenances in the reverse position of that in the engraving on p. 473 (this journal, December, 1890); that is to say, so that the ammonia directly evaporated into the atmosphere, and operated exactly as I did, when determining the latent heat of liquid ammonia. All changes of temperature in the second calorimeter could therefore only be caused by the influence of the temperature of the first calorimeter and of the air. Making observations and calculations as above, we obtain one value for $\delta_1 = \tau - \tau_m$ indicated by the thermometer, another value by calculation. If the letters have the same meaning as indicated, and the observations give:

	1.	*2.*
m,	35′	30′
$\frac{T + T_m}{2}$,	18°·99	19°·30
$\frac{\vartheta + \vartheta_m}{2}$,	20°·03	20°·96
$\frac{T_m + T_n}{2}$,	13°·81	14°·20
$\frac{\vartheta_m + \vartheta_n}{2}$,	20°·08	20°·57
τ,	22°·54	23°·82
τ_m,	22°·23	23°·33

Jour. Frank. Inst., Vol. CXXXI. June, 1891. (*Strombeck.*)

SECOND SERIES OF AUTHENTIC PROOFS FOR THE DETERMINATION OF THE HEAT OF EVAPORATION, ETC., OF LIQUID AMMONIA.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10	11.	12.	AVERAGE.
P,	136·5 grs.	136·7	134·0	142·5	142·7	135·5	144·6	143·4	141·7	140·5	142·2	145·9	
$P - P_1$,	0·1 grs.	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	[illegible]	0·1	
P_1,	136·4 grs.	136·6	133·9	142·4	142·6	135·4	144·5	143·3	141·6	140·4	142·1	145·8	
μ,	3516·0 grs												
σ,	0·0939												
$\mu\sigma$,	330·1 grs.	These values are the same in all 12 tests.											
$\mu_1\sigma_1$,	10·0 grs.												
ω,	3694·0 grs.	3709·0	3690·0	3715·0	3721·0	3728·0	3725·0	3731·0	3752·0	3722·0	3728·0	3715	
M,	4034·1 grs.	4049·1	4030·1	4055·1	4061·1	4068·1	4065.1	4071·1	4092·1	4062·1	4068·1	4055·1	
ϕT,	7448 mm.	7184	7198	7842	8044	7856	7596	7514	7229	7314	[illegible]	[illegible]	
ϕT_m,	5446 mm.	5297	5271	4200	5813	5776	5448	5375	5216	5296	5247	515[illegible]	
$\phi \frac{T + T_m}{2}$	6388 mm.	6166	6177	6692	6861	6757	6456	6269	6810	6244	[illegible]197	6119	6428 mm. or 124·5 lbs. absol. press.
f,	5872 mm.	5859	6158	6254	6458	6358	5816	6135	5552	5526	6160	6009	6018 mm. or 115·7 lbs. absol. press.
T_0,	16°·98	16·92	18·43	18·92	19·95	19·45	16·70	18·11	15·37	15·24	18·49	17·68	17°·69 Cels. or 63°·84 Fahr.
m,	42′	33	35	35	38	36	40	37	37	34	10	42	
T,	24°·40	23·26	23·27	26·04	26·85	26·10	25·06	24·70	23·42	23·80	2[illegible]·68	2[illegible]	
T_m,	14°·79	13·68	13·78	15·97	16·69	16·50	14·82	14·40	13·48	13·94	[illegible]·60	13·1[illegible]	
$\frac{T + T_m}{2}$	19°·595	18·47	18·52	21·00	21·77	21·30	19·94	19·55	18·45	18·87	18·64	18·24	19°·53 Cels. or 67°·15 Fahr
ϑ,	21°·94	22·25	20·20	21·20	21·20	21·52	20·25	20·50	19·48	21·40	[illegible]	20·64	
ϑ_m,	21°·10	21·75	19·61	20·70	21·40	21·00	20·69	20·30	19·08	20·66	19·40	19·90	
$\frac{\vartheta + \vartheta_m}{2}$	21°·52	22·00	19·90	20·95	21·30	21·26	20·47	20·40	19·28	21·03	19·70	20·27	
n,	10′	10	15	10	10	10	10	10	10	10	10	10	
T_n,	14°·96	13·89	14·03	16·12	16·81	16·62	15·00	14·52	13·64	14·12	13·76	13·30	
$T_m - T_n$	— 0°·17	— 0·21	— 0·25	— 0·15	— 0·12	— 0·12	— 0·18	— 0·12	— 0·16	— 0·18	— 0·16	— 0·20	
$\frac{T_m + T_n}{2}$	14°·88	13·78	13·90	16·04	16·75	16·56	14·91	14·46	13·56	14·03	13·68	13·20	
ϑ_n,	21°·06	21·75	21·30	20·56	21·10	20·88	20·73	20·12	19·30	20·52	19·30	19·80	
$\frac{\vartheta_m + \vartheta_n}{2}$	21°·08	21·75	19·50	20·63	21·25	20·94	20·71	20·21	19·19	20·59	19·35	19·85	
δ,	— 0°·221	— 0·307	— 0·143	0·005	0·048	0·004	— 0·066	— 0·065	— 0·087	— 0·201	— 0·108	— 0·258	
$T_m + \delta$,	14°·569	13·73	13·637	15·975	16·738	16·504	14·754	14·335	13·393	13·739	13·492	12·842	
$T - (T_m + \delta)$,	— 9°·831	— 9·887	— 9·633	— 10·065	— 10·112	— 9·596	— 10·306	— 10·365	— 10·027	— 10·061	— 10·188	— 10·538	
$M[T - (T_m + \delta)]$,	— 39659·2 C.	— 40033·5	— 38821·0	— 40814·6	— 41064·8	— 39037·5	— 41894·9	— 42196·9	— 41031·5	— 40868·6	— 41445·8	— 42732·7	
ξ,	317·4												
c,	[illegible]												
c_1,	[illegible]												
μ_2,	[illegible]												
σ,	0·09[illegible]	These values are the same in all 12 tests.											
$\mu_2\sigma$,	[illegible]												
$\mu_3\sigma_3$,	[illegible]												
[illegible]	[illegible]												
ω_1,	588·0 grs.	598·0	606·0	595·0	585·0	596·0	608·0	604·0	599·0	603·0	592·0	602·0	
M_1,	747·3 grs.	757·3	765·3	754·3	744·3	755·3	767·3	763·3	758·3	762·3	751·3	761·3	
τ,	24°·05	23·15	22·94	25·10	25·91	25·32	23·99	23·80	22·88	23·43	23·20	23·10	
τ_m,	22°·75	22·30	21·84	23·76	24·34	24·08	22·83	22·50	21·64	22·33	21·88	21·76	
$\frac{\tau + \tau_m}{2}$	23°·40	22·72	22·37	24·43	25·12	24·70	23·41	23·15	22·26	22·88	22·54	22·43	
τ_n,	22°·38	22·00	21·30	23·37	23·93	23·74	22·53	22·12	21·26	21·93	21·48	21·38	
$\tau_m - \tau_n$,	0°·37	0·30	0·51	0·39	0·41	0·34	0·30	0·38	0·38	0·40	0·40	0·38	
$\frac{\tau_m + \tau_n}{2}$	22°·565	22·15	21·55	23·56	24·13	23·91	22·68	22·31	21·45	22·13	21·68	21·57	
δ_1,	0°·963	0·561	0·775	0·903	1·090	0·809	0·788	0·898	0·941	0·827	0·939	1·005	
$\tau_m + \delta_1$,	23°·713	22·861	22·585	24·663	25·43	24·889	23·618	23·398	22·581	23·157	22·819	22·765	
$\tau - (\tau_m + \delta_1)$,	— 0°·337	— 0·289	— 0·355	— 0·437	— 0·480	— 0·431	— 0·372	— 0·402	— 0·299	— 0·273	— 0·381	— 0·335	
$M_1[\tau - (\tau_m + \delta_1)]$,	— 251·8 C.	— 218·9	— 271·7	— 329·6	— 357·3	— 325·5	— 285·4	— 306·8	— 226·7	— 208·1	— 286·2	— 255·0	
$\frac{T + T_m}{2} - \frac{\tau + \tau_m}{2}$	— 3°·80	— 4·25	— 3·85	— 3·43	— 3·35	— 3·40	— 3·47	— 3·60	— 3·81	— 4·01	— 3·90	— 4·19	
$M_1[\tau - (\tau_m + \delta_1)] + Pc\left[\frac{T + T_m}{2} - \frac{\tau + \tau_m}{2}\right]$	— 515·5 C.	— 514·2	— 533·9	— 577·9	— 600·2	— 559·8	— 540·4	— 569·2	— 501·0	— 494·4	— 568·2	— 565·7	
$M[T - (T_m + \delta)] + M_1[\tau - (\tau_m + \delta_1)]$,	— 39911·0 C.	— 40252·4	— 39092·7	— 41144·2	— 41422·1	— 39363·0	— 42180·3	— 42503·7	— 41258·2	— 41076·9	— 41732·0	— 42987·7	
s,	0·02 C.	0·006	0·02	0·05	0·05	0·04	0·06	0·05	0·03	0·02	[illegible]	[illegible]	
q_1,	— 4·7 C.	— 4·6	— 4·6	— 4·7	— 4·7	— 4·7	— 4·7	— 4·7	— 4·6	— 4·6	— 4·6	— 4·7	
s_1,	— 263·3 C.	— 294·9	— 262·2	— 248·3	— 242·9	— 234·2	— 255·0	— 262·4	— 274·3	— 286·3	— 282·0	— 310·7	
s_2,	— 804·5 C.	— 802·8	— 781·8	— 882·5	— 890·2	— 799·2	— 908·3	— 907·4	— 864·8	— 850·9	— 880·5	— 908·8	
q_2,	— 439·2 C.	— 259·8	— 14·8	— 364·2	— 318·9	— 308·0	— 574·8	— 253·7	— 535·9	— 606·4	— 26·2	— 99·1	
Q,	— 40886·7 C.	— 41015·5	— 39622·5	— 42137·9	— 42383·6	— 40831·2	— 43403·7	— 43397·7	— 42380·0	— 42263·3	— 42352·1	— 4368[illegible]	
$\lambda = \frac{Q}{P}$	— 299·6 C.	— 300·0	— 295·7	— 295·7	— 297·0	— 296·9	— 300·2	— 302·6	— 299·1	— 300·8	— 297·8	— 299·3	— 298·7 French or — 537·7 English thermal units
$q = q_2/P$,	— 3·2 C.	— 1·9	— 0·1	— 2·5	— 2·2	— 2·3	— 3·9	— 1·8	— 3·1	— 4·4	— 0·2	— 0·7	— 2·2 French or — 4·0 English thermal units.
$r = \frac{Q - q}{P}$	— 296·4 C.	— 298·1	— 295·6	— 293·2	— 294·8	— 294·6	— 296·3	— 300·8	— 296·0	— 296·4	— 297·6	— 298·6	— 296·5 French or — 533·7 English thermal units.

	1.	2.
$\frac{\tau + \tau_m}{2}$,	22°·385	23°·575
n,	10′	10′
τ_n,	22°·08	23°·06
$\tau_m - \tau_n$,	0°·15	0°·27
$\frac{\tau_m + \tau_n}{2}$,	22°·155	23°·195
we have δ_1 by observation,	0°·31	0°·49
we have δ_1 by calculation,	0°·289	0°·470

If, in the following table,

μ = the weight of the first calorimeter and its appurtenances;

σ = the specific heat of the metal (brass) of which it was made;

$\mu\,\sigma$ = its value in water;

$\mu_1\,\sigma_1$ = the value in water of the two thermometers;

ω = the weight of the water filled into the first calorimeter;

$M = \omega + \mu\,\sigma + \mu_1\,\sigma_1$;

$\phi\,T$ = the tension of the ammonia vapor at $T°$;

$\phi\,T_m$ = the tension of the ammonia vapor at $T_m°$;

$\phi\,\frac{T + T_m}{2}$ = the tension of the ammonia vapor at $\frac{T + T_m}{2}$;

m = the number of minutes which the test lasted.

T = the temperature of the first calorimeter at the commencement of the test;

T_m = the temperature of the first calorimeter at the end of the test;

$\frac{T + T_m}{2}$ = the average of both temperatures;

ϑ = the temperature of the air at the commencement of the test;

ϑ_m = the temperature of the air at the end of the test;

$\frac{\vartheta + \vartheta_m}{2}$ = the average of both temperatures;

n = the number of minutes during which observations were made for the determination of δ and δ_1, respectively;

T_n = the temperature of the first calorimeter at the end of the n minutes;

$T_m - T_n$ = the fraction of a degree by which the temperature of the first calorimeter changed during the n minutes;

$\frac{T_m + T_n}{2}$ = the average of both temperatures;

ϑ_n = the temperature of the air at the end of the n minutes;

$\frac{\vartheta_m + \vartheta_n}{2}$ = the average of both temperatures;

δ = the fraction of a degree which is to be added to or subtracted from T_m so as to obtain the temperature:

$T_m + \delta$ which the first calorimeter would have had if no external influence had taken place;

$T - (T_m + \delta)$ = the corrected number of degrees by which the first calorimeter was cooled down;

$M\,[T - (T_m + \delta)]$ = the loss of heat undergone by the first calorimeter;

μ_2 = the weight of the second calorimeter and its appurtenances;

$\mu_2\,\sigma$ = its value in water;

$\mu_3\,\sigma_3$ = the value in water of the thermometer;

ω_1 = the weight of water filled into the second calorimeter;

$M_1 = \omega_1 + \mu_2\,\sigma + \mu_3\,\sigma_3$;

τ = the temperature of the second calorimeter at the commencement of the test;

τ_m = the temperature of the second calorimeter at the end of the test;

$\frac{\tau + \tau_m}{2}$ = the average of both temperatures;

τ_n = the temperature of the second calorimeter at the end of the *n* minutes;

$\tau_m - \tau_n$ = the fraction of a degree by which the temperature of the second calorimeter changed during the *n* minutes;

$\frac{\tau_m + \tau_n}{2}$ = the average of both temperatures;

δ_1 = the number of degrees which is to be added to τ_m so as to obtain the temperature:

$\tau_m + \delta_1$ which the second calorimeter would have had if no external influence had taken place;

$\tau - (\tau_m + \delta_1)$ = the corrected number of degrees by which the second calorimeter was cooled down;

$M_1 [\tau - (\tau_m + \delta)]$ = the loss of heat undergone by the second calorimeter;

$\frac{T + T_m}{2} - \frac{\tau + \tau_m}{2}$ = the difference between the average temperatures of both calorimeters;

and if the other letters have the same meaning as in my first article on this matter, we obtain from the tests and by calculation the figures given in the accompanying table:

ON THE HEAT OF FORMATION OF FLUORIDES.

BY JOS. W. RICHARDS.

[*Read at the meeting of the Chemical Section, held April 21, 1891.*]

Until the heat of formation of some fluorine compound from its elements was known, it was manifestly impossible to determine the heat of formation of the fluorides. On the other hand, as soon as the heat of formation of any fluorine compound had been determined, that of any other fluorine compound could be deduced from this by the calorimetric measurement of a double reaction, in which the first compound took part and the second was produced. Many data of this latter kind had been accumulated before the fundamental datum of the first kind was obtained, for the simple reason that free fluorine is required in order to determine primarily the heat of formation of a fluorine compound, while the double reactions referred to above only investigate the thermal differences between various fluorine compounds, and so do not require free fluorine.

Guntz, in 1883,* published some data which he miscalled "Heats of Formation of Fluorides." Under this caption he gives the following figures:

Potassium	fluoride,	38·2 cal.
Sodium	"	39·9 "
Barium	"	35·7 "
Strontium	"	35·9 "
Calcium	"	33·3 "
Ammonium	"	37·3 "

The writer knows of at least one well-educated chemist who was misled by the manner in which Guntz gives these figures, into quoting 39·9 calories as the real heat of formation of sodium fluoride. However, on examining Guntz's paper in detail, we find that he neutralized the metallic hydrates in solution by aqueous hydrofluoric acid, and having determined the collateral data—the heat of solution of the hydrates, fluorides and hydrofluoric acid—he calculated the heat which would be developed if gaseous hydrofluoric acid acted on the solid hydrates, forming solid fluorides and solid water. These numbers he called the heats of formation of these fluorides, and they are the numbers given above.

---

* *Comptes Rendus*, **97**, 1483, 1558; **98**, 816.

In 1884,* Guntz published a memoir on "Thermal Researches on the Combinations of Fluorine with Metals," in which he gives the heats of neutralization of the hydrates of potassium, sodium, ammonium, calcium, strontium, barium, magnesium, lead and silver, in aqueous solution by hydrofluoric acid. He also gives the heats of solution in water of the fluorides of potassium, sodium, ammonium, silver and antimony (the others being insoluble), and of gaseous and liquid hydrofluoric acid. With these data, it was possible for Guntz to calculate the absolute heat of formation of the above fluorides, expressing them as a certain excess above the heat of formation of gaseous hydrofluoric acid, which was an unknown quantity in all the equations. His results were as follows (calling the unknown quantity, [H, F], X):

$$R\ (\text{solid}) + F\ (\text{gas}) = RF\ (\text{solid})$$

Potassium, ...	KF	71·7 + X cal.
Sodium, ...	NaF	71·8 + X "
Calcium, ...	½ (CaF^2)	74·3 + X "
Strontium, ...	½ $(Sr\ F^2)$	71·0 + X "
Magnesium, ...	½ (MgF^2)	67·2 + X "
Lead, ...	½ $(Pb\ F^2)$	15·1 + X "
Silver, ...	$Ag\ F$	— 11·9 + X "
Antimony, ...	⅓ $(Sb\ F^3)$	8·5 + X "
Silicon, ...	¼ $(Si\ F^4)$	29·9 + X "

Guntz even went so far as to make a guess as to what the value X might be, with a somewhat remarkable result. He argued that since chlorine gas does not decompose anhydrous potassium fluoride, the heat of formation of the latter must be superior to that of potassium chloride, which is 105·0 calories. Further, if the difference between these two numbers is assumed to be similar to that between the heats of formation of potassium chloride and bromide, we may add this difference to 105·0 calories, and call the result the heat of formation of potassium fluoride, which can then be placed equal to 71·7 + X, and X evaluated. Guntz here makes two serious and almost incomprehensible blunders. There is absolutely no warrant for the above assumption, and it could be true only by the merest accident. Further, Guntz assumes the difference spoken of as 4·6 calories. Where this number comes from is incomprehensible, for the difference derived from Thomsen's data is 10·3, and the source of the number 4·6 is veiled in mystery. However, using this number, the value of X found was 37·5 calories. That this number was the true one could be possible only by the greatest chance, as it rested on a false assumption and the use of a wrong datum, yet by a strange fortuity this number is only 0·1 calorie from the direct determination made five years later. Guntz deserves much credit for the work he did, but he can hardly claim any renown from this prediction.

---

* *Annales de Chimie et de Physique*, [vi,] **3**, 5.

Two years later,* Moissan isolated fluorine, and found that it decomposed solid potassium chloride in the cold, disengaging chlorine, thus making it probable in a high degree that the heat of formation of potassium fluoride was greater than that of the chloride, that therefore 71·7 + X calories was greater than 105·6, and consequently X greater than 33·9 calories.

In 1889,† Berthelot and Moissan succeeded in determining, experimentally, the heat of formation of hydrofluoric acid. They found:

$$\text{H (gas)} + \text{F (gas)} = \text{HF (gas)} + 37{\cdot}6 \text{ calories.}$$

This was the key which unlocked the question of the heats of formation of the fluorides, for since Guntz had determined the heat of solution of hydrofluoric acid gas in water as 11·8 calories, the heat of formation of the fluorides in aqueous solution could then be calculated from the heats of neutralization of the metallic hydrates by aqueous hydrofluoric acid.

---

* *Comptes Rendus*, **102**, 1543.

† *Idem*, **109**, 209.

In 1889 and 1890,[*] E. Petersen, of Copenhagen, did good service in the line we are considering, by determining the heats of neutralization of most of the metallic hydrates by hydrofluoric acid.

The following table gives the data obtained by Guntz and Petersen:

	HEAT EVOLVED BY THE REACTION $Q+2HF$ aq.			
Q.	*Guntz.*		*Petersen.*	
$2LiOHaq$,	—		32·80	cal.
$2KOHaq$,	32·30	cal.	32·20	"
$2NaOHaq$,	32·60	"	§32·54	"
$2TlOHaq$,	—	"	32·90	"
$2NH^4OHaq$,	30·40	"	—	
$Ba(OH)^2aq$,	*34·80	"	32·30	"
$Sr(OH)^2aq$,	*35·80	"	35·47	"
$Ca(OH)^2aq$,	*37·26	"	36·31	"
$Mg(OH)^2$,	*30·40	"	30·12	"
$Be(OH)^2$,	—		19·68	"
$Mn(OH)^2$,	—		23·10	"
$Zn(OH)^2$,	—		25·10	"
$Cd(OH)^2$,	—		25·56	"
$Fe(OH)^2$,	—		26·53	"
$Co(OH)^2$,	—		26·49	"
$Ni(OH)^2$,	—		27·67	"
$Cu(OH)^2$,	—		20·17	"
PbO,	*22·2	"	—	
Ag^2O,	14·6	"	—	
$\frac{1}{3}Fe^2(OH)^6$,	—		15·83	"
$\frac{1}{3}Al^2(OH)^6$,	—		23·42	"
$\frac{1}{3}Cr^2(OH)^6$,	—		16·78	"
$\frac{1}{3}Mn^2(OH)^6$,	—		17·21	"
$\frac{1}{3}V^2(OH)^6$,	—		17·41	"
$\frac{1}{4}SiO^2aq$,	†11·3	"	—	
$\frac{1}{3}B^2O^3aq$,	‡9·2	"	—	
$\frac{1}{3}Sb^2O^3aq$,	10·1	"	—	

---

* Resulting fluoride precipitated.

† An excess of acid, 8 HF, had to be used, forming a fluorhydrate.

‡ Determined by Thomsen.

§ Thomsen found the same value.

In order to use these data correctly, we must notice the fact of the insolubility of some of the fluorides. Petersen found that by working with very dilute solutions all the fluorides he tried were soluble excepting those of strontium, calcium, magnesium and lead. Guntz, for instance, found barium fluoride nearly insoluble, and gave his value as a close approximation to that for precipitated barium fluoride, while Petersen dissolved it in a large excess of water and obtained a result 2·50 calories lower, showing the heat of solution of barium fluoride to be close to or a little less than 2·50 calories. The heats of solution of the following fluorides have been determined:

---

[*] *Zeitschrift für physikalische Chemie*, **4**, 385; **5**, 253.

Potassium fluoride,	+ 3·6 cal.	Per formula weight of salt dissolved.
Sodium "	— 0·6 "	
Ammonium "	— 1·5 "	
Silver "	+ 3·4 "	
Antimony "	— 4·0 "	

For the above fluorides, then, we can calculate their heats of formation anhydrous as well as in aqueous solution. We can do this, approximately, for barium fluoride also. For the insoluble fluorides their heat of formation in the solid state only can be found. For all the other fluorides we can calculate only their heat of formation in aqueous solution, and this only when we know the heat of formation of the metallic hydrate to start with. This latter factor is not known with respect to beryllium, chromic, manganic and vanadic hydrates.

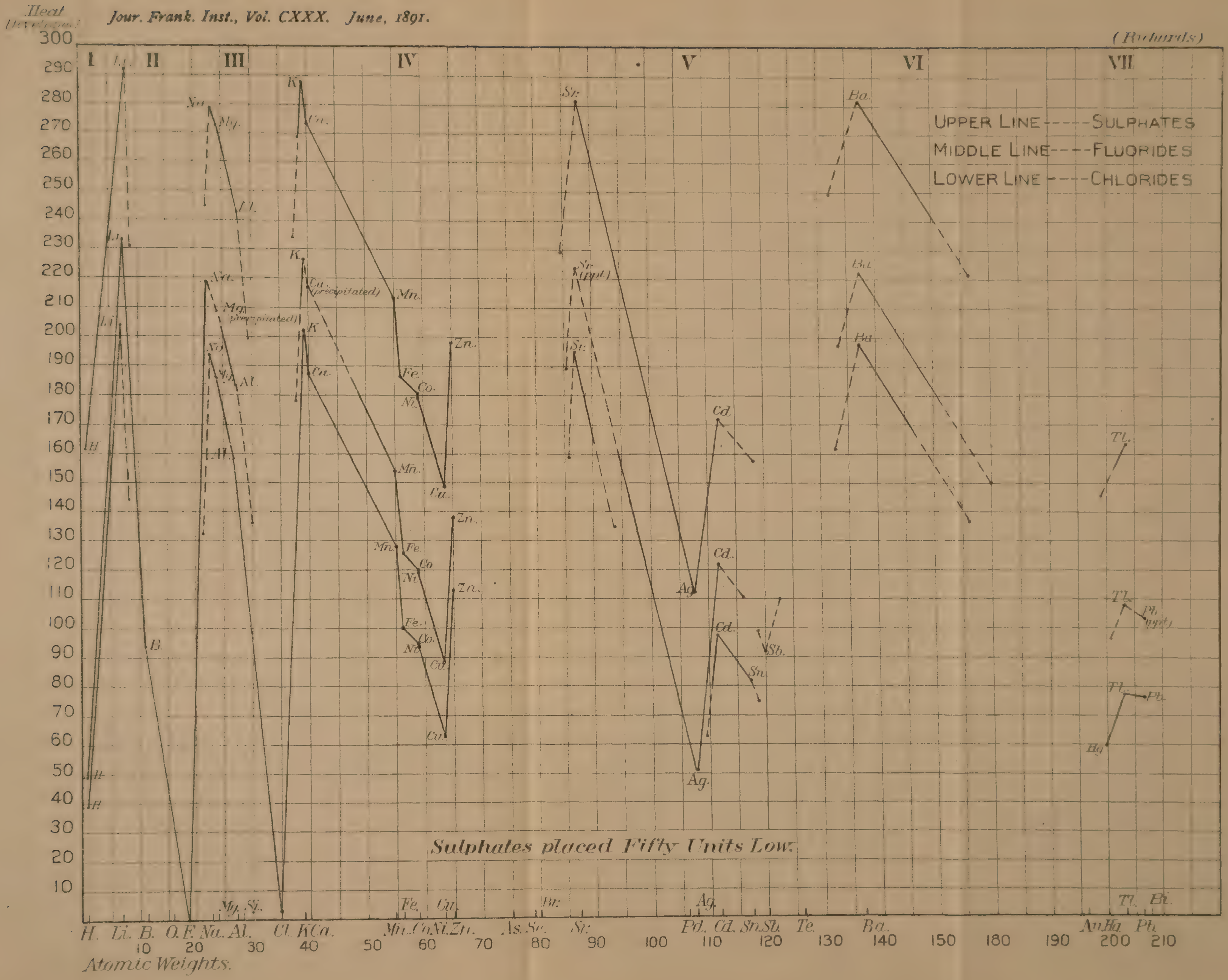
Starting with the data thus presented, the writer has calculated the heats of formation of those fluorides for which there is sufficient data, using generally the heats o formation of the hydrates as given by Thomsen.

HEATS OF FORMATION OF FLUORIDES.

M.	*Products Solid.* [MF^2]	*Heat of Solution.* [MF^2, aq]	*Products Dissol.* [MF^2, aq]
Li^2, ...	—	—	233·76
K^2, ...	220·00	+ 7·20	227.20
Na^2, ...	219·44	— 1·20	218·24
Tl^2, ...	—	—	108·81
$[NH_4]^2$, ...	202·50	—3·00	199·50
Ba, ...	224·00	—2·50	221·50
Sr, ...	224·02	—	—

Jour. Frank. Inst., Vol. CXXX. June, 1891.

(Richards)



HEATS OF FORMATION OF FLUORIDES.—(*Continued.*)

M.	*Products Solid.* $[MF^2]$	*Heat of Solution.* $[MF^2, aq]$	*Products Dissolved.* $[MF^2, aq]$
Ca,	216·90* 216·00†	— —	— —
Mg,	209·50	—	—
Mn,	—	—	153·31
Zn,	—	—	138·22
Cd,	—	—	121·72
Fe,	—	—	125·22
Co,	—	—	120·34
Ni,	—	—	118·98
Cu,	—	—	88·16
Pb,	100·71* 102·50*		
Ag^2,	44·14	+ 6·8	50·94
⅓Fe^2,	—	—	109·96
⅓Al^2,	—	—	183·48
½Si,	137·96	—	—
⅓Sb^2,	92·79	— 1·67	91·12
⅓B^2,	—	—	146·23

* Based on Guntz's experiment.

† Based on Petersen's experiment.

In the large diagram accompanying this paper, I have used the atomic weights of the elements as abscissas, and the heat of formation of their fluorides in aqueous solution as ordinates. The resultant connecting line, though fragmentary, shows very clearly the periodic variation of these heats of formation with the increase of atomic weight, dividing the elements into seven families corresponding to the seven families of the well-known classification of the elements by the Periodic Law. Mr. A. P. Laurie, in 1883,[*] arranged the chlorides in this way, and I have placed the chloride line on the diagram as well as the line of the sulphates (the latter brought down fifty units for convenience in drawing the chart). An inspection of the diagram shows a very near approach to parallelism in these three lines, the variations being hardly perceptible on the chart; but, if we tabulate the numerical differences between the heats of formation of these three classes of compounds, we will discern the irregularities more easily. We will only compare those elements for which we know the heats of formation of the three salts, all in aqueous solution with the exception of those marked with a star.

---

[*] *Philosophical Magazine*, **15**, 41.

	CHLORIDES FROM FLUORIDES.		FLUORIDES FROM SULPHATES.	
M.	$[MF^2, aq] - [MCl^2, aq]$	*Deviation from mean difference.*	$[MSO^4, aq] - [MF^2, aq]$	*Deviation from mean difference*
Li^2,	29·36	+ 4·17	106·56	— 3·92
K^2,	24·99	— 0·20	111·22	+ 0·74
Na^2,	25·22	+ 0·03	111·21	+ 0·73
Ba,	24·69	— 0·50	110·98	+ 0·50
Sr,	*28·03	+ 2·84	*106·90	— 3·58
Ca,	*28·77	+ 3·58	*106·55	— 3·92
Mg,	*22·57	— 2·62	*113·16	+ 2·68
$\frac{1}{3}Al^2$,	24·93	— 0·26	109·57	— 0·91
$\frac{1}{3}Fe^2$,	24·81	— 0·38	—	—
Mn,	25·31	+ 0·12	110·34	— 0·14
Zn,	25·38	+ 0·19	110·27	— 0·21
Cd,	25·47	+ 0·28	110·56	+ 0·08
Fe,	25·27	+ 0.08	110·38	— 0·10
Co,	25·52	+ 0·33	110·13	— 0·35
Ni,	25·28	+ 0·09	110·37	— 0·11
Cu,	25·35	+ 0·16	110·30	— 0·18
Mean value, omitting the insoluble fluorides and lithium,	25·19	—	110·48	—

An inspection of this table shows us at once the irregularity in the case of the insoluble fluorides. Magnesium fluoride is 2·62 calories too low in one case and 2·68 in the other, or a mean of 2·65. It is therefore probable that when this fluoride precipitates from a solution it absorbs about 2·65 calories, and that if it could be retained in a very dilute solution, its heat of formation would be 2·65 calories greater. Similarly, the heat of formation of calcium fluoride in aqueous solution might be about 3·75 calories, and of strontium fluoride 3·25 calories less that when the fluorides are precipitated. But what are we to say of lithium, that pattern of good behavior in all its other thermal relations? Here is certainly an anomaly, whose explanation, I think, lies in the fact that lithium fluoride is the most nearly insoluble salt of lithium, and Petersen has either omitted to say that there was a precipitate in this case, or he has given us a wrong value for the reaction. We have very strong grounds for concluding that the true heat of formation of lithium fluoride in aqueous solution is about four calories less than the value which is deduced from Petersen's experiments on neutralization. The variations in the case of the other fluorides in the above table are so small that we may conclude that we know their true heat of formation within the limits of experimental error.

THE DIAZOTYPE PROCESS OF PHOTOGRAPHIC DYEING AND PRINTING.

By John Carbutt.

[*Communicated to the Chemical Section, April 21, 1891.*]

The subject I have the pleasure to bring before the Section this evening is the "Diazotype Process of Photographic Dyeing and Printing," the discovery of Mr. Arthur G. Green, of London. It is a new method of producing designs in fast colors on cotton, linen, silk, paper, etc., either from hand-drawn designs on a transparent or semi-transparent medium, or by use of a photographic transparency.

It was first made public at a meeting of the British Association for the Advancement of Science, held at Leeds last September.

It is distinctly a positive process; that is, it yields a positive from a positive. The operations are five in number, viz: dyeing, sensitizing, printing, developing and washing, corresponding very closely in number of operations required in preparing and printing on paper by the direct silver process of photographic printing. Primuline is the base of the new "diazotype," and is already in extensive use for dyeing calico in various tints.

Dyeing.—The first operation, then, is to dye our material with "primuline." To do this take 100 grains of "primuline," add to it twenty ounces of distilled water brought to a boil in a flask over a Bunsen burner; when dissolved, pour into a porcelain dish, and immerse the fabric, cotton cloth (the cotton must be free from dressing), or silk, and as soon as the pieces seem thoroughly impregnated with the dye, remove and rinse in plain water, and squeeze as dry as possible, or place between sheets of blotting paper. The fabric so prepared has a primrose hue, and so far is insensitive to light.

Sensitizing.—The second operation, or sensitizing, is accomplished by immersing the dyed fabric in a solution formed of sodium nitrate sixty grains, cold water thirty-two ounces, oxalic acid 100 grains, previously dissolved in two ounces of water. Each piece is immersed separately and soaked for two or three minutes, it is then rinsed in water and dried. The color of the fabric should be of a reddish-yellow hue, and is sensitive to light; the operation should be performed in a weak light, and the pieces dried in the dark.

Printing.—Place in a printing frame a glass transparency, and place over it a diazotized fabric in contact, and expose to daylight ten to twenty minutes, or sunlight four to seven minutes. The greater the contrast in the transparency, the greater will be the contrast in the finished print, the action of daylight being to decompose the azo derivative, and so prevent reaction with the "developers," so-called, to be afterwards applied; but if we take a piece of the sensitive material that has not been exposed to light, and apply one or more of the developers, or, as a dyer would call it, a "mordant," we at once develop the full tint or color by the action of that particular solution used. This I will now illustrate.

Developing.—I have here a piece of porcelain coated with a solution of gelatine and primuline, and sensitized in the same bath as the cotton cloth. I now paint over one-fifth of its surface, consecutively, with each of the following five solutions or developers:

No. 1, as you see, develops a red color.
No. 2 produces a yellow.
No. 3 produces an orange.
No. 4 produces a purple.
No. 5 produces a dark brown or black.

It only remains to well rinse this in water, when the colors will be found fixed and permanent. This demonstration will illustrate the possibility of producing the several colors on one and the same picture, as follows: Mix a portion of each developer with a thin starch paste, and, with a camel's-hair pencil, paint over the parts wanted of a particular color, with the particular solution intended to supply that color, of course in a weak light, as the image is faintly visible after exposure under the transparency.

The composition of the five developers just used is as follows—and it is only right to say here that I am indebted for the formulæ of these solutions to two photographic journals, *The British Journal of Photography* and *Anthony's Photographic Bulletin*:

DEVELOPERS.

No. 1—Red.

Betanaphthol,	30 grains.
Caustic soda,	40 grains.
Water,	10 ounces.

No. 2—Yellow.

Crystallized carbolic acid,	50 grains.
Water,	10 ounces.

No. 3—Orange.

Resorcin,	30 grains.
Water,	10 ounces.
Caustic soda,	45 grains.

No. 4—Purple.

Naphthylamin,	60 grains.
Water,	10 ounces.
Oxalic acid,	6 grains.

No. 5—Black.

Eikonogen,	50 grains.
Water,	10 ounces.

Transparencies on glass, and positives on celluloid and opal, can be produced as shown by the specimens I have here, and which can be inspected at the close of the meeting.

The composition of the coating is as follows:

Water (distilled)	20 ounces.
Gelatine,	1 ounce.
Primuline,	80 grains.
Chrome alum,	2 grains.

Put the gelatine to soak in six ounces of water, dissolve the primuline in twelve ounces of hot distilled water, and when dissolved add the gelatine and the chrome alum—dissolved in the remaining two ounces of water—filter through cotton, and flow while warm on the glass or porcelain. When dry immerse for two minutes in the sensitizing solution, wash for five minutes and allow to dry in the dark. The operation of printing and developing is the same as for prints, or cotton, etc.

PROCEEDINGS.

[*Proceedings of the stated meeting, held Tuesday, June 16, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, June 16, 1891.

Dr. W. H. WAHL, President, in the chair.

Ten members present.

Nominations :

Dr. W. P. Mason, Troy, N. Y.

Oliver Hough, 325 South Sixteenth Street.

Owing to the absence of the election committee, a motion was made by Mr. Bower to suspend the rules, so as to permit of the election of the above gentlemen by the Section. Carried.

Dr. Mason and Mr. Hough were then elected.

Mr. Garrison's paper was postponed until further notice.

Dr. Koenig read an interesting paper on "A Remarkable Boiler Scale from Galveston, Tex." Referred for publication.

Mr. Ives gave some illustrations of the results he has obtained in color photography.

Prof. Trimble presented a paper on "The Tannin of the Chestnut Wood." Referred for publication.

Dr. Wahl exhibited a new incandescent gas lamp, similar in structure to the Welsbach incandescent lamp, but said to possess more lasting properties.

Adjourned. LEE K. FRANKEL, *Secretary pro tem.*

ON THE PERCENTAGE OF IODINE ABSORBED BY LARD OIL BY THE HÜBL METHOD.

BY REUBEN HAINES.

[*Read at the stated meeting of the Section, held March 17, 1891.*]

The examination of lard oil for adulterations is of importance not only from an economical point of view, but also because admixture with a partially drying oil, such as cotton-seed, renders it unsuitable for lubrication and deteriorates its quality for oiling yarns in textile industries. Adulteration with unsaponifiable substances and hydrocarbon oils or waxes would seriously interfere with its use in textile manufactures. It also has been said, that admixture with cotton-seed increases risk of fire from spontaneous combustion in oily waste.

Lard oil does not appear to be of so extensive commercial importance in Europe as it is in this country, where in addition to its use as a lubricant and in textile manufacture, it is still extensively used as an illuminating oil by the United States Lighthouse Board.

Hence, while many other fixed oils, both animal and vegetable, have been investigated in Europe with more or less completeness, one finds in foreign scientific journals few references to chemical examination of lard oil, although lard itself is frequently mentioned. The writer, therefore, thought it worth while to collect together the few scattered references that exist in regard especially to the iodine absorption percentage of lard oil by Hübl's method, and to present the results of a number of examinations made by himself several years ago which have never appeared in print.

Alfred H. Allen (*Analyst*, **13**, 164) found the percentage of iodine absorbed to be seventy-four per cent. in a sample of oil pressed out in his laboratory from lard known to be entirely pure.

J. Campbell Brown stated in a discussion that the percentage iodine absorbed was from seventy-five to eighty per cent. (*Analyst*, **13**, 173.)

Rowland Williams (*Analyst*, **13**, 164) found the percentage to be seventy-three per cent.

T. S. Gladding found it to be 74·60 per cent. (*Analyst*, **14**, 32.)

Thomson and Ballantyne (*Jour. Soc. Chem. Industry*, **9**, 590) found 76·2 per cent. for prime lard oil. On the other hand, Mr. Allen found that an oil *believed* to be pure, which had been kept on hand for several years, absorbed only forty-one per cent. iodine; and he quotes also the result obtained by W. Moeller, of New York, who found in one sample only 47·2 per cent. absorption of iodine. (*Analyst* **13**, 164).

The figures obtained in my own analyses agree approximately with Mr. Allen's result for pure lard oil pressed out in his laboratory, and with that of Mr. Gladding.

It is difficult to believe that the oils for which Mr. Allen and Mr. Moeller obtained such very low numbers were not adulterated oils and therefore not representative. As lard is composed chiefly of olein and stearine and as pure oleic acid absorbs eighty-five to eighty-six per cent. iodine while pure stearic acid absorbs no iodine at all, commercial stearine less than thirty per cent., and pure lard ranges from fifty-one to sixty-five per cent. with an average for mixed commercial lard of sixty to sixty-two per cent., it is reasonable to expect that lard oil, which is composed chiefly of the olein pressed out of the lard and more or less perfectly freed from the lard stearine, should have a higher absorption number than the whole unpressed lard, and the correct figure would probably be somewhere nearly midway between the figures for lard and for pure olein, or oleic acid. This seems to be really the case in the majority of instances at least. The amount of stearine left in the oil depends upon the temperature at which the pressing of the lard is conducted. I found by experiment that the oil obtained would not begin to chill or congeal until it had reached a temperature several degrees below that at which it had been pressed out. Thus an oil pressed at 50° F. did not begin to chill or become cloudy until the temperature was below 45° F.

As the percentage of iodine absorbed by cotton-seed oil ranges from 105 to 115 per cent. with an average of 108 to 109 per cent., this average being about the figures usually found; and if we assume, as is probably true, that the correct number for prime lard oil is seventy-two to seventy-four per cent., we have a difference of about thirty-five per cent. between the iodine absorption capacities of lard oil and cotton-seed oil. This affords a sufficient range for calculating the percentage of adulterant used. Even assuming these figures as tolerably constant, I have found it difficult to obtain constant and reliable results showing less than five per cent. of cotton-seed in lard oil in experiments upon known mixtures of these oils, partly on account of the slightest variation of temperature in the laboratory or drafts of cold air from a window seriously affecting the correct reading of the column of iodine solution in the burette which is a nearly saturated solution of iodine and mercuric chloride in ninety-five per cent. alcohol. A difference of 0·1 cc. will cause a variation of nearly 0·5 per cent. of iodine absorbed by the oil as the method is usually conducted. It is absolutely necessary to have the burette protected from drafts of air and to have a delicate and accurate thermometer hung in close proximity to the burette during the whole time of the test or series of tests made in the course of the day, and frequently to observe whether any alteration of temperature has occurred. It is also necessary to use only chloroform of the highest grade of purity for solution of the oil in the flask. I now use only that grade which is sold for purposes of inhalation for medical purposes. It is also now believed that for most oils the time for absorption allowed by Hübl in his original paper is not sufficient, and that for drying, semi-drying and fish oils, the time should be extended to six hours at least, and even eight hours appears to be still better, but that it should not in any case exceed twenty-four hours. I diluted the liquid in the flask (after addition of potassium iodide solution), with 100 cc. of water instead of 150 cc. as recommended by Hübl, as otherwise the one-quarter litre flasks used became inconveniently full for the proper manipulation if a large excess of iodine remained after the absorption. In the later tests I preferred to leave a large excess of unabsorbed iodine, and this is now considered to be necessary by those who have used this process. When this excess equals the percentage absorbed an increase of the quantity of potassium iodide is necessary up to thirty cc. of the ten per cent. solution instead of ten to fifteen cc. recommended by Hübl. Exactly the same measured quantities of both chloroform and of the potassium iodide solution should be used in the oil tests and in the blank titration tests of the alcoholic iodine solution. The hyposulphite solution should not be kept on hand very long but should be made up fresh every few weeks at longest. The alcoholic iodine solution, when freshly prepared, should stand forty-eight hours before being used in analysis, and only very pure ninety-five per cent. alcohol should be used for preparing it. The flasks used should have glass stoppers accurately fitting, and should be kept at a uniform temperature during the whole experiment. The burettes should be corked at the top when not actually running out solution, or, for the iodine solution at least, it is far better to use the new form of burette, glass stoppered at the top, with a small hole for admission of air, which is closed when not in actual use. The amount of lard oil weighed off for each test was from 0·30 to 0·40 gram, dropped into the same one-quarter litre flask to be used in titrating the oil. Usually, about 0·35 gram was taken, as this seemed to be most convenient.

On comparing the iodine absorption percentages obtained for different oils, it will at once appear that this method alone by no means assures us of the fact that the adulterant is really cotton-seed oil, since a number of other oils, such as rape-seed, sesame and peanut or ground-nut oil have nearly the same iodine absorption numbers as cotton-seed. But the applications of other tests as may seem desirable, such as Bechi's test with an acid alcoholic solution of silver nitrate (omitting the amyl alcohol and rape-seed oil originally prescribed by Bechi); the temperature reaction with ten cc. concentrated sulphuric acid (sp. gr. 1·84) and fifty grams of oil; the melting point of the fatty acids obtained by saponification of the oil, and the elaidin test as described by Allen, will prove conclusively the presence of cottonseed and almost certainly differentiate the other oils that could be present. The accurate determination of the specific gravity by weighing is generally important, and the presence of any unsaponifiable matter should be noted. The color test by nitric acid may, in some cases, prove useful as also the pure sulphuric acid color tests. All, or nearly all, the other very numerous color tests that have been proposed and used are said to be unreliable or absolutely useless in a mixture of oils of a miscellaneous origin. Other tests may be applied as indications seem to suggest.

My experiments gave results as follows:

I obtained three-pound cans of leaf lard, said to be entirely pure, from each of two well-known lard manufacturers in this city, out of freshly made stock and also a quantity of country lard from a farmer who was accustomed to supply my family with lard. Portions of each of these samples were examined for impurity or adulteration. They all responded satisfactorily to the usual tests for pure unadulterated lard. I did not test the lard by Bechi's test, but subsequently examined the oil by that method. I then pressed out the oil from these separately, using for this purpose a small screw press of the kind made for drugs. The temperature of the room was regulated so that it never exceeded 55°, nor fell below 45° F. Most of the time it stood slightly below 50° F. The pressure was applied gradually, and increased to the utmost that the press was capable of standing. The press was wiped dry after each experiment, and each oil sample was bottled separately.

The samples of lard before expression gave the following results to tests:

	Melting Point.	*Iodine Absorption, Per Cents.*					
Lard No. 1, ...	45° C.	62·9	62·1	61·9		average,	62·3
Lard No. 2, ...	45°	62·65	62 12	62·76	62·42	"	62·49
Country Lard, ...	33°*	59·24	59.42			"	59·33

---

* This figure is too low.

The country lard was much softer than the others, which fact corresponds with the melting point above given.

These iodine figures correspond nearly with those given by Hübl and others. Hübl gives two determinations in his original paper, viz: 57·6 per cent. and 60·0 per cent. (*vide* also E. W. T. Jones, *Analyst*, **13**, 170). In this country, chemists give a somewhat higher figure for American lard. Thus, R. W. Moore gives 61·9 (*Amer. Chem. Journal*, **6**, 417) and Prof. H. W. Wiley, United States Department of Agriculture, Division of Chemistry, *Bulletin* 13, part 4, p. 418, states that the mean percentage for prime steam lards is 62·86, and for pure lards of other kinds 62·48 per cent. The higher percentage for American lards is accepted by English chemists (*vide Analyst*, **13**, 169). Wiley also states, however, that lard rendered from different parts of the animal gives different iodine absorption percentages, according to the amount of olein contained in it. Thus, a sample of intestinal lard absorbed 57·34 per cent.; leaf lard from the same animal, 52·55 per cent.; foot lard, 77·28 per cent.; and head lard 85·03 per cent. But, as the lard now manufactured in this country is more or less of fat from parts of the whole animal, it has usually an iodine figure closely approximating to 62 per cent. English and other foreign lard is still strictly omentum, or leaf lard, which was the old-fashioned article of this country twenty or thirty years ago.

(1) The lard oil made as above stated from lard No. 1 gave the following percentage absorption of iodine:

74·54; 75·22; 75·95; 74·91; 75·09. Average, 75·14 per cent.

(2) The oil pressed out from lard No. 2 gave results as follows:

73·68; 73·06; 72·52; 72·96; 72·91. Average, 73·03 per cent.

(3) The oil made from the sample of country lard gave:

70·12; 70·45; 70·39; 69·72; 69·33. Average, 70·01 per cent.

Oil No. 1, contained free fatty acid 0·86 per cent., calculated as oleic acid.
" 2, " " 0·49 " " "
" 3, " " 1·35 " " "

Average percentage of iodine absorbed in all three oils together is 72·72 per cent.

In a sample of extra prime lard oil, obtained from a dealer in this city, manufactured in Chicago, but guaranteed to be strictly pure by the Philadelphia firm, gave results as follows for iodine absorbed:

73·10; 75·09; 74·03; 73·88. Average, 74·02 per cent.

This sample had an acidity equivalent to 0·85 per cent. oleic acid. All the above examinations were made about five years ago.

Recently I have re-examined the identical samples of oils above-mentioned to learn if any change had taken place in the iodine absorption percentage during a period of five years in a corked bottle, part of the time exposed to diffused light and part of the time kept in a dark closet, the corks being occasionally removed, the bottles warmed up to liquefy the chilled oil, and portions removed. The oil made from lard No. 1 now gives me iodine absorbed 72·34 and 72·33 in consecutive tests. The extra prime lard oil of Chicago manufacture now gives me iodine absorbed 73·73 per cent.

The acidity for these oils does not appear to have altered much, but has not yet been determined quantitatively.

There seems, therefore, to have been no change of iodine absorbed beyond the limits of experimental error.

PROF. LIPPMANN'S HELIOCHROMY.

BY F. E. IVES.

[*A communication to the Chemical Section, April 21, 1891.*]

At the March meeting of this section, I made some comments upon the alleged solution of the problem of photography in natural colors by Prof. Lippmann, of Paris, expressing some doubt as to the possibility of obtaining such alternate zones of "light and darkness" in proximity to the mercury mirror as are called for by Prof. Lippmann's theory, and also as to the possibility of reproducing the compound colors by means of interference laminæ. I afterwards communicated my doubt to Prof. Himes, of Dickinson College, and asked for an expression of his opinion. He kindly wrote me a long letter, from which I quote as follows:

"As far as I have been able to follow Prof. Lippmann, I am more hopeful than you perhaps are in the direction of compound colors, and more nearly satisfied with the theoretical explanation, although, of course, at this early stage it must be regarded, of course, only as provisional, and there are many questions that both of us would like to ask, some of which Prof. Lippmann might possibly be able to answer by this time and others I am just as certain he could not. I will just note hastily the points upon which I have less difficulty and doubt than you seem to have, premising first that you concede the fact that Prof. Lippmann has succeeded in getting a photographic impression of the spectrum in which can be recognized at least the colors in their order—some say brilliant and perfect—but I think Prof. Lippmann's account is more moderate and modest. But this is not the greatest feature of Prof. Lippmann's publication. This has been done long ago and by many, and possibly better than he has accomplished it, but he has succeeded in *fixing* it, and that by the ordinary photographic method, and his whole process, withal, is so simple and complete that it invites and encourages experiment with it, which I have great hope will lead to practical results.

"As to his theory we may think what we please. With me it has this in its favor, that the appearance of all previously obtained heliochromic results by Becquerell and others, whether flowing from systematic investigation or from accident, as in many cases, conforms to that of Prof. Lippmann's results, and can best be described as that of *interference* colors. There are even those who intimate that after all Prof. Lippmann adopted a theory and line of investigation already outlined.

"I have no difficulty in regard to the interference of direct and reflected waves so as to produce so-called stationary waves of definite length and frequency. The ocular demonstration of such waves, usually employed in lectures, by means of a stretched spiral cord or gum tube, attached at one end to a hook, and held at the other end by the hand, on which regularly timed impulses by the hand produce interfering direct and reflected waves, is very satisfactory at this point. The completed analogue in case of sound is to me conclusive of the plausibility of the theory of Prof. Lippmann. Savort, in the early part of the century and more recently Lord Rayleigh (in 1888) by a series of classical experiments demonstrated the presence of stationary sound waves, with their spaces of sound and silence by the interference of direct waves with those reflected from a board using a sensitive flame to explore the space. A double reflecting surface may be necessary to present interference colors to the eye as you state, as the rays should both be moving toward the eye, but to produce the stationary luminous undulations, or zones of maximum movement or maximum energy and zones of rest or of minimum movement; of the ether particles, the interference of an incident and reflected ray from one surface will be sufficient condition. These are hardly to be called zones of light and darkness. A ray of light is invisible as such; it produces visible effects, so here the zones of differing energy in the ether particles produce varying effects upon the film in which they are formed, effects which we recognize as photographic.

"These effects are not the production of pigment colors, as up to this time seems to have been the expectation in heliochromy, but they are rather in nature of change of structure, laminated deposits of silver, so to say.

"As to the rendering of compound colors, I have not seen much claimed as accomplished in this direction. There is a well-grounded hope, I believe, but the rendering of the spectrum and the perfect fixing of it are the chief claims of Prof. Lippmann, as I understand it. I would not draw, or allow the theory to draw, the line of the impossible too near to the present achievement to prevent investigation and experiment with compound colors. The whole doctrine of perception of compound colors would not permit us to deny such possibility. Prof. Lippmann has certainly started scientific thought and investigation, as far as heliochromy is concerned, in a new direction, by results that commend our admiration and a theory that is not only possible, but a most excellent working hypothesis."

Capt. Abney, who recently visited Prof. Lippmann, also appears to endorse his theories, but does not regard his process as a step in the direction of practical photography in colors. The following report of Capt. Abney's remarks upon this subject, at the recent Camera Club Conference, is from the London *Photographic News*, of April 10th:

"Photography in natural colors was the next question to which the President turned his hearers' attention. The 'accomplished fact,' as some of the newspapers led their readers to suppose, is as old as photography, for the discovery of photography in colors has been made, according to some people, over and over again. Being in Paris a week ago he had the opportunity of visiting M. Lippmann. He found that gentleman to be a true man of science, with all the modesty of a real investigator. The color plates about which we have heard so much are due to interference, and not to pigments, and their effect varies according to the angle at which the plate on which they appear is held. Capt. Abney then proceeded to describe how these colors are obtained, by use of a mercury trough, as already detailed in our pages. He pointed out that, to obtain the colors, exposure to a bright spectrum was necessary, and that development must be brought about by alkaline carbonates, and the image intensified with silver. Both exposure and development must be exactly correct, or no colors are apparent, and the best results are gained with dry plates prepared with albumen and collodion. He looks upon the results of M. Lippmann's experiments merely as a verification of Newton's law, and not as a discovery of photography in color. M. Lippmann has certainly succeeded in fixing interference colors, but the process is clearly one of extreme difficulty. It is a misfortune both for M. Lippmann and his predecessor, Dr. Koch, that their experiments should have been dealt with by the ordinary reporters, because these reports have led the general public to expect far more than the experiments in either case justified."

COMPOSITION OF BOILER SCALE AND THE COMPOSITION OF THE FEED WATER FROM GALVESTON, TEX.

BY GEORGE A. KOENIG.

[*Read at the stated meeting of the Chemical Section, held June 16, 1891.*]

The city of Galveston is built upon a narrow tongue of land which separates the Gulf of Mexico from Galveston Bay. I am informed that the surface of this land consists of a conglomerate or natural concrete, some twelve to eighteen inches thick. Over this extends sand three to four feet thick, and under the concrete a bed of quicksand of very great depth; its depth being practically unknown. The conglomerate offers very good foundation for all buildings. To obtain feed water for steam boilers, several of the industrial establishments have driven tube wells into the quicksand to great depth. The well of the Galveston Rope and Twine Company, whose water is the subject of this paper, is said to be 1,500 feet deep. It is probable that the sinking was continued until the flow of the quicksand stopped.

The water from this well is perfectly clear, and no sediment was found in the vessel. It has a very salty taste, and contains, in 1,000,000 parts:

SiO_2, ... = 29·9
Fe_2O_3, ... = 3·5
Al_2O_3, ... = 1·5
CaO, ... = 132·8
$MgCl_2$, ... = 197·6 (MgO = 83·2)
NaCl, ... = 5489·3
SO_3, ... = 1·99

CO_2 was not determined; but from the composition of the scale it must be inferred that there is probably a little more CO_2 present in the water than is required to hold the calcium in solution as hydro-carbonate. Since the percentage of sodium chloride is 0·55, and since the sea washes, so to speak, the very locality, the conclusion might easily be reached that this artesian water is simply filtered sea water. This view is surely entertained at the locality, and is also held by some chemists. There are several reasons why this view must be abandoned. The supply of these artesian wells has nothing in common with sea water. An analysis of the water taken in the surf of Atlantic City this spring gave me, in 1,000,000 parts:

$(SiO_2 + Al_2O_3 + Fe_2O_3)$, ... = 6·0
SO_3, ... = 1965·0
$NaCl$, ... = 23320·0

Sea water, then, contains about one-fifth as much of silica, ferric and aluminum oxides; it contains 1,000 times more of SO_3 and over four times as much of NaCl. What could have become of the sulphates if this artesian water were filtered sea water? It is simply inconceivable to suppose that the filtering through fine quartz sand would remove the sulphates, which are very soluble. We might understand that the flowing through the quartz would increase the silica in the water, but again we could not account for the loss of three-fourths of sodium chloride. Thus we are brought to the only possible explanation, namely, the existence of a deposit of rock salt under the quicksand. We know that there is such a deposit at the mouth of the Mississippi River, of probable Miocene age, and which has been exploited for many years. We know that whenever a salt bed forms from evaporation out of sea water the sulphates crystallize out first; the salt always overlies either anhydrite or gypsum, even the kieserite ($MgSO_4 + H_2O$) is found at Stassfurt, in the lower levels. The top beds always contain the easily soluble chlorides of magnesium and calcium and potassium, as at Stassfurt, but not necessarily everywhere. I tested five grams of the salt obtained by evaporation of the Galveston water for potassium, but found much less than there is in the sea water at Atlantic City. This is surely another anomaly, but notwithstanding, I think the evidence is strongly in favor of assuming the top strata of a salt bed as the source of the Galveston artesian water. The Galveston Rope and Twine Company having observed that the boiler-plates of a neighboring establishment had been very rapidly destroyed by the forming of pin holes, resolved to have the matter investigated before their new boilers (from the Edgemoor Iron Company) had suffered a similar fate, and sent samples of their feed water as well as of their scale. After investigation, the writer proposed the use of soda ash as a preventive. But some other parties having recommended tri-sodium phosphate, a new sample of the scale was submitted some four weeks later. The analyses of both samples (*A*) before and (*B*) after the use of the tri-sodium phosphate are here given:

	A.	*B.*
SiO_2,	= 11·86	18·76
Fe_2O_3,	= 2·80	2·40
Al_2O_3,	= 0·30	0·66
P_2O_5,	= 0·10	0·58
CaO,	= 9·20	7·64
MgO,	= 43·74	40·28
CO_2,	= 8·86	9·72
H_2O,	= 23·14	19·96

The scale is thin and gray in color. It disintegrates easily. Under a power of 500 diameters it is resolved into an aggregate of single crystals, some prismatic, some tabular. The latter show a hexagonal combination of the basal plane with a positive and negative rhombohedron and resemble the mineral brucite (MgH_2O_2). The prismatic crystals are six-sided with the basal plane. However, they appear to be orthorhombic from their behavior in polarized light.

The substance gelatinizes with hydrochloric acid. There must be consequently a silicate present. The variation in the percentage of silica (this has been called sand, erroneously) is striking. It would be very interesting if the nature of the silicate could be ascertained. It might by chrysolite, which gelatinizes with hydrochloric acids. Assuming this to be the case, and it seems probable because the form is orthorhombic, analysis *A* would assume the following mineralogical interpretation:

Chrysolite (Mg_2SiO_4),	= 27·67
Aragonite ($CaCO_3$),	= 16·4
Hydromagnesite ($CO_3Mg_2H_2O_2$),	5·0
Brucite, (MgH_2O_2),	37·0
Götheite $(FeH)O_2$,	3·2
Hygroscopic water, etc.,	11·0

It is clear that the destruction of the boiler iron is caused by the formation of magnesium hydrate from the chloride, according to the equation

$$MgCl_2 + 2H_2O = MgH_2O_2 + 2HCl$$

If a sufficient quantity of Na_2CO_3 be added to the water, there is no precipitate formed at ordinary temperature; but at 80° C. a flocculent deposit follows of magnesium or calcium carbonates.

Analysis *B* shows that the tri-sodium phosphate had very slight effect. It would not be well to reject it on this account, because it may not have been introduced properly. But it seems to me that the carbonate should be recommended in such cases. The latter is on trial at Galveston now, and after some time another sample of the scale will be submitted.

PROCEEDINGS.

[*Proceedings of the stated meeting, held Tuesday, September 15, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, September 15, 1891.

Dr. W. H. WAHL, President, in the chair.

Thirteen members and two visitors were present.

Mr. Pemberton nominated Mr. W. N. Allen, No. 2 Chestnut Street, Philadelphia, for membership in the Section. Owing to the absence of a majority of the committee on admissions, action upon the nomination was deferred.

Mr. Pemberton reported that Mr. Henry Bower and himself were present at the meeting of the Committee of the American Chemical Society, held during the past summer, in Washington, for the purpose of considering the establishment of a national chemical organization. He reported progress, and the committee was continued.

A number of bills, presented by the Actuary of the Institute, were considered by the Section, and the President was instructed to approve them for payment.

A paper by Mr. Cabell Whitehead, of the Mint Bureau in Washington, on "The Use of Cadmium in Assaying Gold Bullion," was read by the Secretary in the absence of the author. Dr. Tuttle commented upon the paper and discussed the most important advantages of the proposed method.

Mr. Waldron Shapleigh, of the Welsbach Incandescent Gas Light Company, of Gloucester, N. J., exhibited a series of specimens of salts of the rare earths. The collection was unique and of great interest and value. No such complete collection of these rare bodies was ever exhibited before a scientific body in this country. Mr. Shapleigh discussed the sources of the minerals from which the salts were obtained, and also the methods of purification used.

The exhibition was highly appreciated by the members present.

The President of the Section tendered thanks to the exhibitor for the rare opportunity he had afforded the members of the Section. (Appended is a list of the preparations exhibited.)

Adjourned. WM. C. DAY, *Secretary.*

Mr. Waldron Shapleigh exhibited the following specimens of salts of the rare earths:

Praseodymium, neodymium and lanthanum oxides, sulphates, nitrates, chlorides, carbonates, oxalates, acetates and double salts with the alkaline metals.

Cerium oxide, oxalate, chloride, nitrate, and the double nitrate of the cerous and ceric oxides with ammonium.

Yttrium and erbium nitrates, oxides and oxalates.

Zirconium oxide, nitrate, sulphate and some double salts.

Yttrium and erbium (not separated) oxides and nitrates obtained from gadolinite, cerite, monazite, fergusonite and samarskite. Thorium and vanadium salts.

Also large specimens of the following minerals from which these salts were obtained: samarskite, zircon crystals and monazite sand from North Carolina, monazite sand from Brazil, gadolinite from Texas and allanite from Virginia.

Mr. Shapleigh said the collection was of interest, as it is the first time the salts of praseodymium and neodymium have been shown, and probably separated in this country. Some of the salts have not been heretofore prepared.

The separation of these elements is long and tedious; the specimens shown having undergone nearly 400 fractional crystallizations, and having been in state of constant preparation since early in 1888. Tons of cerite and monazite sand have been used, and tons of the salts of cerium and lanthanum obtained, but the yield of praseodymium oxide has been only a few kilos. The percentage of neodymium is much higher.

Dr. Carl Auer von Welsbach, in 1885, was the first to separate didymium into these elements, and together with Prof. Bunsen, to determine their atomic weights; that of Pr 143·6 and of Nd 140·8. The oxides are M_2O_3 and probably $M_4 O_7$.

With one exception, the salts of praseodymium exhibited were of a pale green, and of neodymium pink or amethystine color.

Zirconium, lanthanum and cerium should no longer be classed among rare earths, as hundreds of tons of ores from which they are obtained have been located in North Carolina, and there seems no end to the deposits of monazite sand, one of the richest ores, and containing most of the rare earths. In Brazil it does not have to be mined, as it is in the form of river sand. In North Carolina it is found in washing for gold.

Should the arts, trades or manufactures create a demand for these so-called rare earths, nature could readily supply it from these two localities.

Thorium and yttrium minerals are not so easy to obtain; they have, however, recently been found in quantity in North Carolina and Texas.

Working on a commercial scale, he finds the yield of lanthanum from cerite nearly one per cent. higher than stated in the analyses published.

CHESTNUT-WOOD TANNIN.

BY PROF. HENRY TRIMBLE.

[*Read at the stated meeting of the Chemical Section, held June 16, 1891.*]

The *Castanea Vesca* of Linnæus or *C. Sativa* of Miller, variety *Americana*, is a large tree of rapid growth, found in many parts of the United States, especially in the eastern section from Maine to Delaware and on mountains as far south as northern Alabama.

An extract of the wood and bark has been prepared in this country and France for a number of years. This extract is especially useful in tanning where it corrects the reddish color of hemlock, and in dyeing where it gives a dead black with salts of iron. It must not be confounded with the extract of chestnut oak, *Quercus Prinus*, Linn., which is also largely manufactured in this country, and, no doubt, the manufacturers are not very particular to keep the two separate.

Most of the literature on the subject of chestnut tannin refers to that from the horse chestnut, *Æsculus Hippocastanum*.

In order to leave no room for doubt about the origin of the tannin described in this paper, the chips, free from bark, were collected from a large tree about forty years old, cut in the month of August.

A summary of the constituents of the wood, as found by a proximate analysis, may be of interest before commencing a description of the tannin:

	Per Cent.
Crystalline wax, melting at 50° C., soluble in hot 95 per cent. and in absolute acohol,	1·03
Gallic acid,	·05
Resin,	·28
Tannin, extracted by absolute alcohol,	3·42
Mucilage,	1·15
Dextrin,	1·89
Sugar,	·96
Tannin, extracted by water,	1·92
Pectin and albuminoids,	1·46

	Per Cent.
Extractive, dissolved by dilute acid,	2·95
Ash,	7·08
Moisture,	7·05
Cellulose and lignin,	70·76
	100·00

It is not certain that the gallic acid pre-existed in the wood, because it may have been formed during the drying of the chips, since the analysis was not made for some time after they were cut and ground.

A special determination of tannin on a separate portion of the wood by gelatin and alum and by permanganate and hide powder gave, respectively, 7·86 and 7·85 per cent.

The tannin used in the following experiments was prepared by percolating two and one-half kilos of the finely powdered wood with a commercial ether, which consisted of about seventy-four parts ether, twenty-six parts alcohol and a small quantity of water. The ether was recovered from the percolate by distillation and the residue dissolved in cold water. The filtered aqueous solution was precipitated in three portions by lead oxy-acetate, the precipitates decomposed by hydrogen sulphide, the latter removed by distillation under reduced pressure, and the solution after cooling agitated with ether, which extracted gallic acid from each of the three fractions. The tannin solution from the middle fraction was warmed to remove ether and then saturated with common salt. An abundant separation of tannin took place, which was collected, washed with a saturated solution of salt, and dried over sulphuric acid in a vacuum.

The dry residue was dissolved in ether-alcohol, filtered and rapidly evaporated to dryness under diminished pressure, which left the tannin in a porous, light-red mass. This was used for some of the qualitative tests, but for many of the reactions the tannin was further purified by again precipitating in three fractions with lead oxy-acetate, the lead removed by hydrogen sulphide, the latter removed by distillation under reduced pressure, until the liquid had reached a small bulk, when it was agitated with ether, which removed gallic acid from each of the three fractions.

The aqueous solution was then distilled to dryness under reduced pressure, the residue in each case dissolved in ether-alcohol, filtered and rapidly distilled under the same circumstances to dryness, which left the tannin in a nearly white porous mass completely soluble in cold water.

In physical and chemical properties this chestnut-wood tannin so closely resembled gallotannic acid that the following comparative statement is given, to show both the character and resemblance at once:

Reagent.	*Chestnut-wood Tannin.*	*Gallotannic Acid.*
Ferrous salts,	No change,	No change.
Ferric chloride	Blue-black ppt.,	Blue-black ppt.
and Ammonium hydrate,	Purple ppt.,	Purple ppt.
Tartar emetic	Slight clouding,	Slight clouding.
and Ammonium chloride,	Pale ppt.,	Pale ppt.
Copper sulphate	No ppt.,	No ppt.
and Ammonium hydrate,	Light-brown ppt.,	Light-brown ppt.
Bromine water,	No ppt.,	No ppt.
Calcium hydrate,	White ppt. turning light blue,	White ppt., turning light blue.
Ammonium molybdate,	Yellow color,	Yellow color.
Sodium sulphide,	No change,	No change.
Conc. sulphuric acid,	Light yellow,	Light yellow.
Sulphuric acid (1 to 9),	No deposit,	No deposit.
Lead nitrate,	White ppt.,	White ppt.
Cobalt acetate,	Flesh-colored ppt.,	Flesh-colored ppt.
Manganese acetate,	White ppt.,	White ppt.
Uranium acetate,	Crimson color, turning dark red,	Crimson color, turning dark red.
Ammonium picrate,	No ppt.,	No ppt.
Potassium bichromate,	Brown ppt.,	Brown ppt.
Ferric acetate,	Blue-black color and ppt.,	Blue-black color and ppt.
Alkaloids,	White ppt.,	White ppt.
Gelatin,	White ppt.,	White ppt.
Lead acetate,	Light ppt.,	Light ppt.

One per cent. solutions of the tannins were used as recommended by Procter,[*] and all the reagents were applied in solution except sodium sulphide. These reactions do not all agree with those given by Procter, but he used a solution of commercial extract of chestnut which may have consisted in part or entirely of chestnut oak, or the difference may be due to the non-tannin constituents of the extract.

---

[*] *Text-Book of Tanning*, p. 112.

The chestnut-wood tannin was found to decompose, when heated to 200° C., into pyrogallic and metagallic acids, an abundant crop of crystals being obtained of the former. Each of the three fractions was estimated for sugar and the first found to contain 10·48, the second 7·98 and the third 6·18 per cent. of glucose, which, no doubt, had existed as a glucoside.

The second fraction was dried at 120° C. and submitted to elementary analysis as follows:

(1) ·1179 grams of substance gave ·2211 CO_2 and ·0486 H_2O.
(2) ·0843 grams of substance gave ·1575 CO_2 and ·0363 H_2O.

	(1)	*(2)*
C,	51·15	50·95
H,	4·58	4·79
O,	44·27	44·26
	100·00	100·00

On calculating for the presence of 7·98 per cent. glucose and deducting the difference from (1), we get:

	Found.	*Calculated for* $C_{14}H_{10}O_9$.
C,	52·11	52·17
H,	4·40	3·10
O,	43·49	44·73
	100·00	100·00

It will be noticed that the percentage of hydrogen is greater than that in digallic acid, but in view of the fact that it was dried at 120° C. instead of 140° C., as recommended by Löwe,* and that it agrees so closely with gallotannic acid in all its reactions, we cannot but conclude that it is gallotannic acid.

An acetyl derivative was prepared which in many respects resembled pentacetyl tannin, but the figures proving it could not be obtained in time for this paper.

---

* *Zeitschrift für Anal. Chemie,* **11**, 378.

PROCEEDINGS.

[*Stated meeting, held at the Institute, Tuesday, October 20, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 20, 1891.

Dr. W. H. WAHL, President, in the chair.

Mr. W. N. Allen, No. 2 Chestnut Street, Philadelphia, was elected a member of the section.

Upon motion it was voted that the section cause to be printed a form of letter to be used by the Secretary for the purpose of informing newly-elected members of their admission to the section.

A letter from Mr. Otto Lüthy was read, announcing that illness prevented him from attending the meeting. The paper which was to have been presented by him was therefore deferred to a future meeting.

Dr. Bruno Terne read a valuable and highly interesting paper on "The Utilization of the Bye-products of the Coke Industry."

The paper was illustrated fully by lantern projections. The paper called forth an extended discussion, in which Dr. Jayne, Mr. Henry Bower, the author and the President took part. The paper and discussion thereon were referred for publication in the *Journal*.

Dr. E. F. Smith presented a paper by himself and Mr. Hough, of the University of Pennsylvania, on (I)—"The Iodation of *p*-Bromobenzoic Acid," and (II)—"Salts of *p*-Bromo-*m*-nitrobenzoic Acid." It was read by title and referred for publication in the *Journal*.

Adjourned. WM. C. DAY, *Secretary*.

NOTES ON SOME CASES OF DRINKING WATER AND DISEASE.

BY WILLIAM P. MASON

[*Read at the stated meeting of the Chemical Section, held May 19, 1891.*]

Drinking water and disease, upon which I am expected to speak to-night, is a question of such exceeding breadth, that so considerable a title certainly outweighs the small amount of matter capable of being placed within the compass of a short paper. I therefore beg to present only some few facts which have come within my own experience, and certain other matter bearing directly thereupon.

In that most excellent treatise upon "Water Supplies and Inland Waters," recently issued by the Massachusetts State Board of Health, waters are classified into "normal" and "polluted," the former being such as are free from addition, directly or indirectly, of either sewage or industrial waste.

The relation of "normal" waters as a class, to sanitary science, constitutes a subject by itself, and one by no means completely understood, as is instanced by the doubt we entertain of the effect of fresh water algæ upon our city supplies. However objectionable such growths may be from an æsthetic point of view, owing to the disagreeable odors generated, we must nevertheless confess to much ignorance as to their pathogenic importance. It has been my fortune to meet with but few cases of illness traceable to normal waters, and in all such instances the patients suffered from a mild and transient form of diarrhœa, caused by water from a low-lying small lake or pond, surrounded by low wooded banks. Of course, as in the experience of other water analysts, the commonly reported cases of algæ have been met with, but no material has so far been secured whereby disease could be traced to their presence. We will all look with interest to the results of the investigation now being undertaken by the American Water Works Association, and we hope for further light upon this point.

As concerning the second division referred to above, namely, polluted waters, permit me, for the moment, to make a further subdivision, and consider the admission of sewage from pathological sources, as distinct from that derived from healthy persons. I ask for the distinction because without it, it would often be hard to account for the long-continued immunity from disease, enjoyed by people who habitually make use of waters which are unquestionably grossly polluted.

How often do the cases of contaminated city wells illustrate this point, and how frequently is the chemist met by this refuting "test of experience," when he knows not only from the results of his own analysis, but from personal inspection of the vaults in the neighborhood, that such wells drain sources of outrageous filth. In view of the over-taxed purifying powers of the intervening soil, there is but one way out of the dilemma, and that is that sewage from pathologic sources has as yet not chanced to reach these wells, or else that such persons as swallow specific germs do not, at the time, furnish suitable ground to grow the seed which disease has planted.

You will remember that Emmerich made very light of the objections raised against ingestion of sewage material, and even went so far as to personally consume no inconsiderable quantity of it daily, and induced some students of his to do likewise. In contrast with his physiological results, permit me to relate a somewhat interesting case with which I was connected.

Rain-water, from a cistern of the filtering type, situated upon carefully managed property, had been in use for some years. Suddenly, with little warning, the entire household, one person excepted, were taken ill. The symptoms varied from intense nausea to great, if not dangerous, prostration. The one person who escaped illness was the only one who did not use the water. Among those attacked were several children.

Upon investigation, both cistern lining and private sewer were found defective, and permitting of more or less direct communication. Up to the time of the outbreak none of the household had suffered from diarrhœa or kindred troubles, nor could I obtain any history of recent disease of any kind. The children attacked were on a short visit only. The point to be emphasized in this case is that the sewage which caused the trouble was "normal." Although I secured an analysis of the water at the time illness was produced, it is to be regretted that no previous analyses were on record, which might have established some relation between the figures of the analysis and the "poisoning point" of the water.

The serious evils lurking in water containing sewage derived from sources of disease, are too well-known to need enlarging upon here, and the dangers to be dreaded from the improper disposal of city drainage, is one of the widely-talked-of topics of the day.

Much has been said and written upon the ability of sewage-laden streams to purify themselves, and authorities of great weight are to be found on either side. Some time since a series of analyses were undertaken, as you will remember, by Dr. Long, of Chicago, upon the dilute sewage contained in the Illinois and Michigan Canal. It is to be noted that this canal receives its supply of water (or rather dilute sewage) at Bridgeport, where the pumps deliver to it the filthy water of the Chicago River, contaminated with a great portion of the sewage of Chicago. From Bridgeport the water "flows along the level to Lockport, twenty-nine miles below, requiring about a day for its passage." It receives no dilution on the way and is frequently agitated by passing boats. "After passing Lockport the water descends to Joliet through four locks, and falls over a dam seven feet in height to point of collection. There is a fall of 58·2 feet in a distance of four miles, and no dilution takes place on the way." The experiments with this canal water have been both numerous and thorough, and judging from the mean results there is good ground for the statement that very considerable self-purification takes place during the flow of thirty-three miles.

I have long been of the opinion, however, that what may be very true for dilute sewage, does not hold good as we approach the limit of potable water.

In other words, so far as purification of a water by the natural processes of oxidation is concerned, I believe that the rate of such purification varies directly as the amount of sewage contamination. Given a stream with a certain amount of pollution, the per cent. of such pollution which must disappear per mile of flow, will continually decrease as the stream flows on. To return to Dr. Long's figures. The analyses as given by him are as follows, in parts per million:

At Bridgeport:

	Free Am.	*Albu. Am.*	*Oxygen Consumed.*
June 26,	2·6	0·64	12·0
July 3,	2·7	0·52	6·8
17,	25·0	1·50	22·4
24,	5·5	0·37	12·6
31,	23·0	1·76	23·2
Aug. 7,	26·0	1·50	16·8
14,	29·0	1·64	32·0
21,	27·2	1·50	28·0
28,	29·2	1·90	35·2

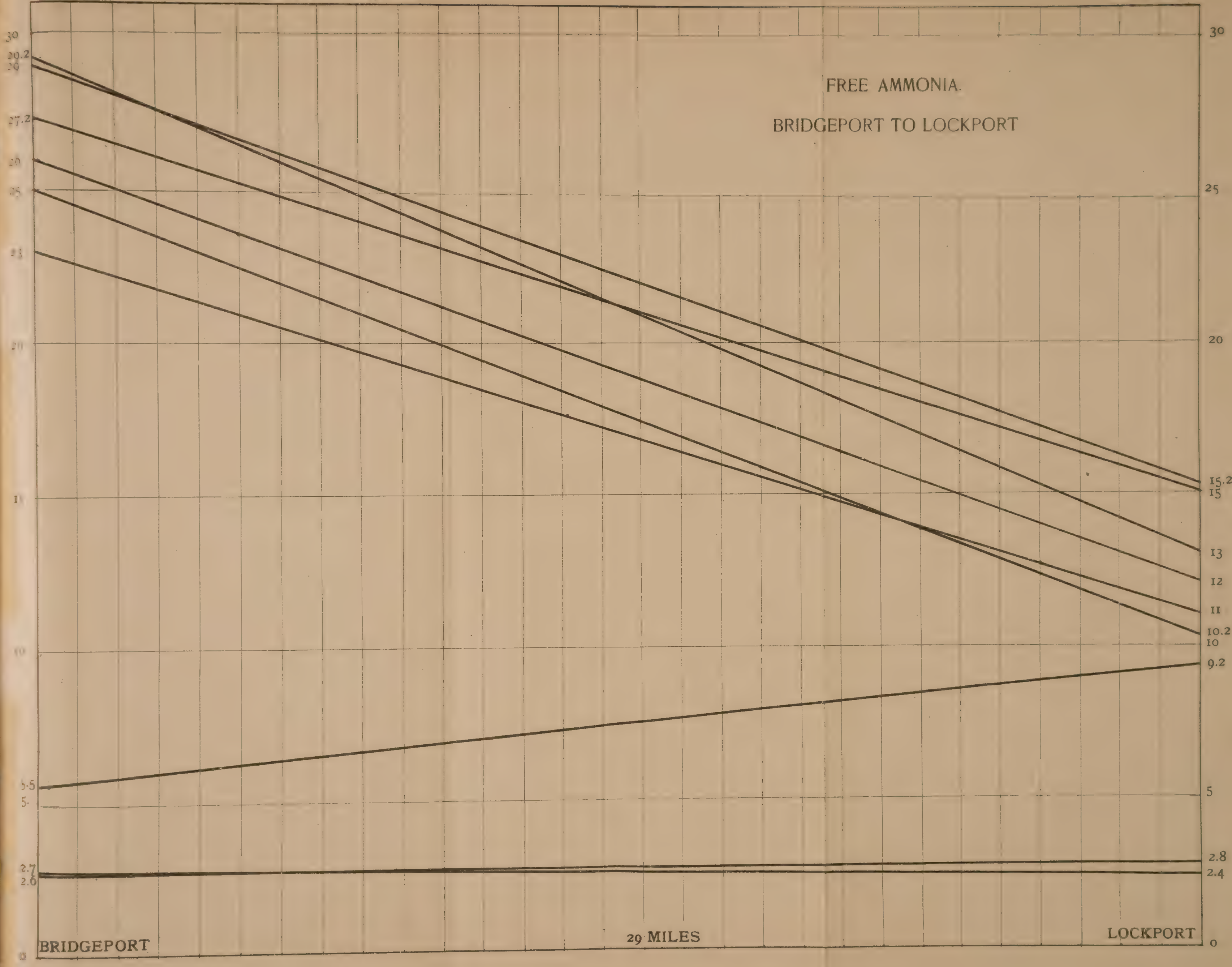
At Lockport:

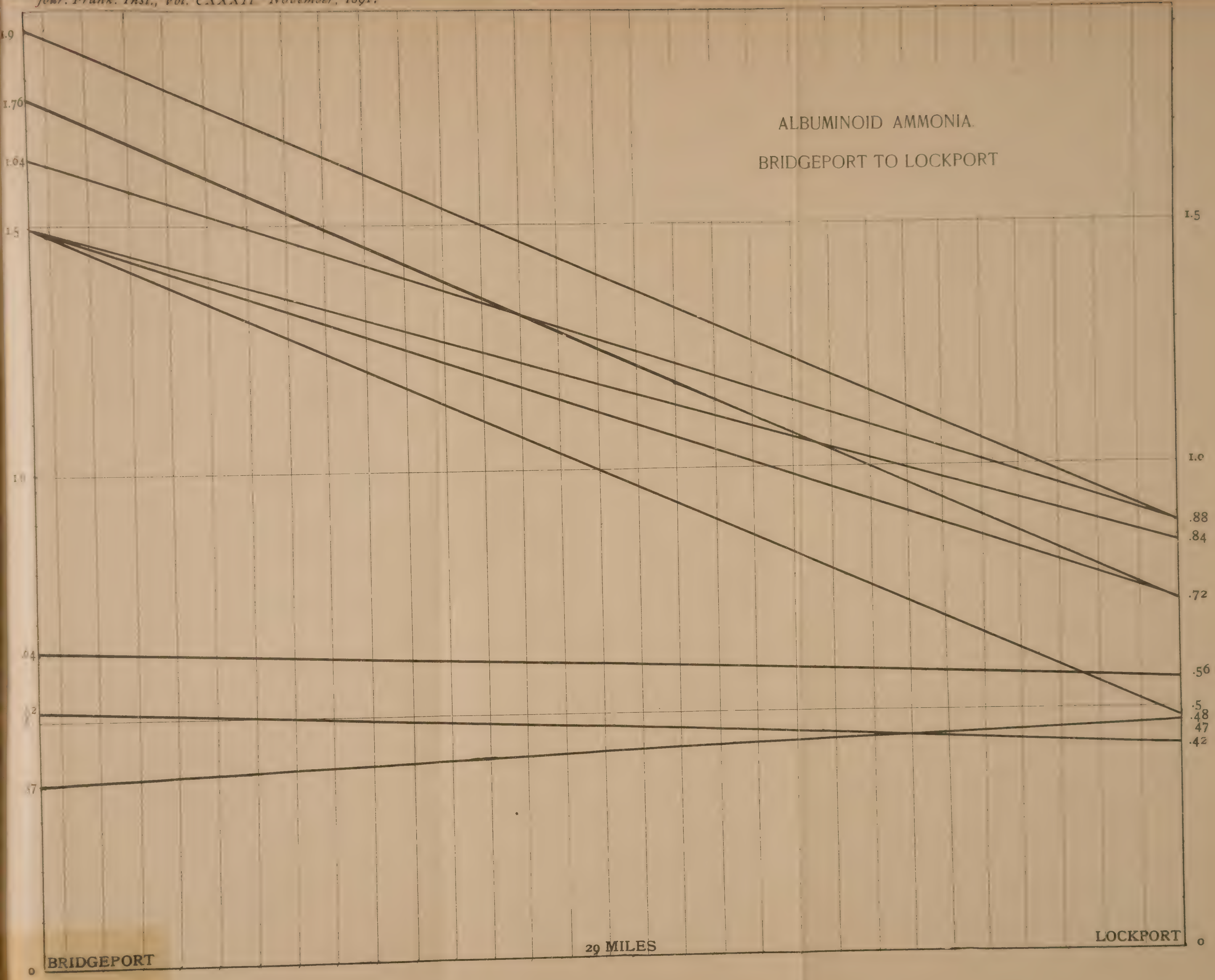
June 26,	2·8	0·56	11·36
July 3,	2·4	0·42	7·20
17,	10·2	0·72	12·80
24,	9·2	0·47	14·80
31,	11·0	0·72	10·70
Aug. 7,	12·0	0·48	9·60
14,	15·2	0·88	9·76
21,	15·0	0·84	10.80
28,	13·0	0·88	12·40

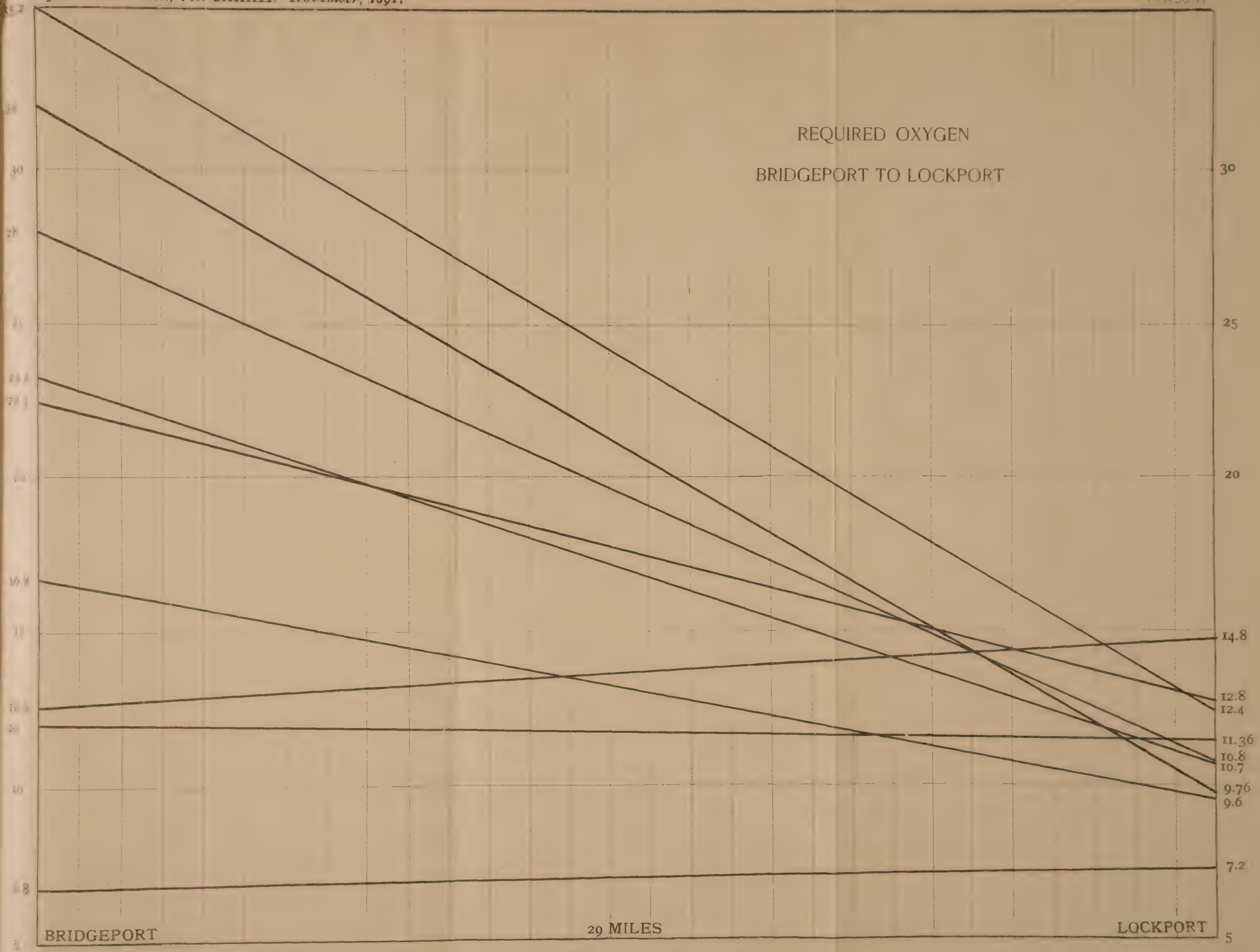
At Joliet:

June 26,	1·7	0·46	7·36
July 3,	1·8	0·46	9·76
17,	13·0	0·44	14·50
31,	9·2	0·44	5·68
Aug. 7,	7·5	0·42	5·84
14,	9·8	0·46	5·76
21,	9·0	0·11	0·52
28,	8·0	0·32	6·80

Jour. Frank. Inst., Vol. CXXXII. November, 1891. (MASON)




ALBUMINOID AMMONIA
BRIDGEPORT TO LOCKPORT
.9
1.76
1.64
1.5
1.0
.64
.52
.37
0
BRIDGEPORT
29 MILES
LOCKPORT
0
1.5
1.0
.88
.84
.72
.56
.5
.48
47
.42


REQUIRED OXYGEN
BRIDGEPORT TO LOCKPORT
30
16.8
10
30
25
20
14.8
12.8
12.4
11.36
10.8
10.7
9.76
9.6
7.2
5
BRIDGEPORT
29 MILES
LOCKPORT

Plating these in graphic form they assume the shape shown on the accompanying charts. The change in lake level at various dates, together with other disturbing influences, caused comparatively clean water to reach the pumps at times, and we, therefore, are furnished with data governing the purification of several variously contaminated waters, while flowing under constant conditions.

It will be noticed that the rate of purification per mile for the more grossly contaminated samples, is much greater than that for those comparatively pure. Thus, during the flow from Bridgeport to Lockport the sample of July 3d loses 11·2 per cent. of its free ammonia and 19·3 per cent. of its albuminoid ammonia, while the sample of August 28th loses 55·5 per cent. free ammonia and 53·7 per cent. albuminoid ammonia while flowing the same distance.

Even the best of these waters of the Illinois and Michigan Canal is very far from being potable, and we may consequently look for still further reduction in the purification rate as we near the potable limit. My experience with the waters of large streams contaminated with city sewage, for instance, the Hudson River, is that self-purification is exceedingly slow. Having been employed by the Board of Health to examine into the quality of the Hudson River water opposite Albany (which water, taken directly from the side of the wharf, constitutes the present city supply), I made a very thorough examination of that section of the river. Permit me to digress here for a moment to state that it is my conviction that analyses of water from any one spot in a large stream, are valueless for the purpose of determining the continued presence of up-stream contamination. The dilution is commonly much too great to permit the sewage revealing itself. The Albany case is one in point. In order to determine whether Troy sewage, entering six miles above, was felt at the Albany intake, the river water was first sampled above Troy and then below the Troy sewer outfalls, where no one would hesitate to say that contamination was serious. A difference was noted between the two results which was undoubtedly caused by the influx of the Troy and Mohawk River sewage.

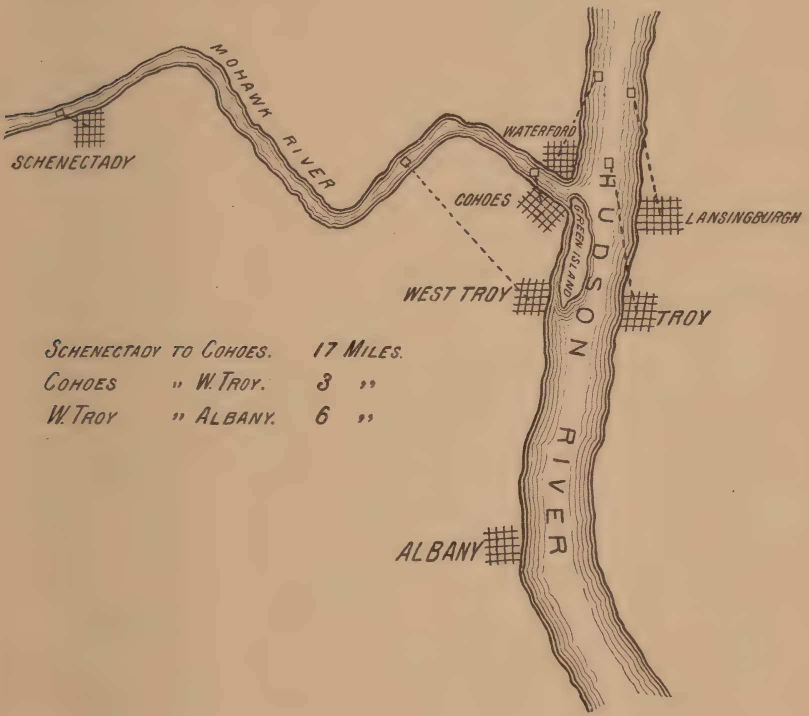
Upon continuing the collection of samples, every mile there were obtained analytical results which showed that the difference between the waters above and below Troy was largely maintained when Albany was reached. On the strength of the maintenance of this difference, rather than upon the results of any separate analysis, I pronounced against the Albany water supply as being contaminated with sewage from up-river sources. Directly relating to what has been referred to, let me finally ask your attention to a few facts of recent history, bearing upon the late outbreak of typhoid fever in Albany and vicinity.

By a glance at the accompanying chart, the locations will be observed of the several cities and towns situated at and near the junction of the Mohawk and Hudson Rivers. Every one of these centres of population drains into the river on whose banks it is situated, and each of them takes the greater portion of its water supply directly from such river by means of pumps. Mark this difference, however, Waterford, Lansingburgh and Troy are supplied with Hudson River water above the junction with the Mohawk, and the village of Green Island obtains its water from wells driven into its sandy soil. It is therefore supplied with filtered Hudson River water, while all the others use Mohawk or Mohawk-Hudson water.

The several intakes are indicated on the chart by squares. Under date of April 11, 1891, the Health Officer of Schenectady writes me: "The marked increase in typhoid fever began in July, 1890, and has just let up. We have had about 300 cases. Doctors have not been particular in reporting them, and we have had so many cases of anomalous fevers, that diagnosis is questionable. Seventy deaths have been reported." Permit me to say that it has not been the rule during this epidemic, for physicians to do their whole duty in reporting cases. I know of one instance in which only two or three cases were reported out of twenty-five. Schenectady is a very old town (of 20,000 inhabitants), and its sewerage system is doubtless none of the best but its drainage eventually reaches the Mohawk and is carried onward with the current.

The following information was obtained from Dr. Leo, Health Officer of Cohoes, and from Dr. Peltier, his predecessor. Population of Cohoes is 22,000.

The epidemic of typhoid began in Cohoes about the end of October, 1890, and ceased about the middle of the following March. Altogether there were about 1,000 cases. The cases were mild in character, resulting in very few deaths. Cohoes takes its entire water supply from the Mohawk and returns its sewage into the same river. Boiling of water for drinking purposes was recommended, and no typhoid developed among families who followed the recommendation, except in those instances where members of such families drank unboiled water while at work away from home. A portion of the city is owned by the great Harmony Knitting Mills, and is built up with tenements for their employés, of which there are many hundreds. These tenements are



kept in excellent repair and the plumbing is the best in the city, but extends to kitchen sinks and drains only. No water-closets are employed, as each house is furnished with privy vault in back yard. Typhoid was especially bad in this quarter. The Cohoes Health Officer has professional occasion to visit in Waterford (population 5,400) and in Lansingburgh (population 10,000), which towns are connected with Cohoes by bridges. He reports that hardly a case existed in either of those towns, and it is to be noted that they draw water from the upper Hudson above the Mohawk junction.

West Troy is situated on the Hudson and sewers therein, but by aid of the chart it will be noticed that its water supply comes from the Mohawk some distance above Cohoes. Its population is 13,000. The following information was obtained from Dr. McNaughton, health officer:

Epidemic of typhoid began the last of November. At meeting of Health Board, about December 15th, fifty cases were reported. Of these, forty-two had used Mohawk water, the remainder well water. On December 20th, the Mohawk supply was shut off and arrangements made with the town of Green Island (which village, by the way, had no fever) to use a portion of its supply of filtered Hudson water. One week thereafter the weekly report of cases showed fifteen, and the second week thereafter but one case was reported. The Green Island supply was used one month. Upon returning to the Mohawk supply in the middle of January, a slight increase in typhoid was observed. Total number of cases exceeded 100. The fever, as in other places, was very mild, resulting in ten deaths. Troy is situated directly opposite West Troy. Its population is 60,000. Its water supply comes partly from lakes back in the hills, partly from the Hudson above the Mohawk junction.

There have been very few cases of typhoid in Troy during the past year, and of those few a large percentage were imported from Schenectady and West Troy.

Troy dumps 8,000,000 gallons of sewage into the Hudson daily.

Six miles below Troy is the city of Albany; population, 100,000. Albany takes its waters through an intake in the side of the wharf, directly in front of the city. Not only does sewage from the upper Hudson and Mohawk flow towards it, but during flood tide and south wind, the return of its own sewage from the sewer outfalls below has been proven by the floating of buoys.

The typhoid epidemic began in Albany the last of December, 1890. The disease was very mild in character, resulting in sixty-two deaths during the months of January, February and March, 1891. The total number of typhoid cases reported during the same period is 411, but this figure I have reason to know is absolutely unreliable. Albany experienced a very serious epidemic during the past winter, and the alarm was widespread, of that there can be no question. A small portion of the city receives its water supply from an inland gravity source. Typhoid was not nearly so plenty in that section, only eighteen cases being reported to the end of March.

An attempt has been made to fix the Albany epidemic upon the bad sanitary conditions of the house drains, whereby sewer air was admitted into the dwellings. In one section visited, sixty-five houses out of seventy-five possessed drains which leaked sewer air, and at the Albany Penitentiary, where the drainage system is perfect and where the inmates drink unpurified river water, there occurred no case of typhoid.

Faulty drainage, permitting the inhalation of sewer air, doubtless would induce a condition of the system favorable to the propagation of the typhoid germ should it be introduced, but it must be remembered that Troy has sanitary surroundings and appliances fully as undesirable as Albany, yet no epidemic occurred there.

Possibly the excellent sanitation at the penitentiary maintained the inmates in a condition of health such as to resist the planting of the disease.

Finally, as I am informed by Dr Craig, of Albany, at Van Wie's Point, four miles below Albany, the laborers employed in cutting ice for the great ice-houses, had typhoid fever break out among them during January. They used river water for drinking purposes.

To conclude, typhoid germs have been carefully looked for in the water and have not been found. But in view of the relative volumes of a city water supply and a sample for bacteriological examination, such a result does not appear surprising. There are those who hold that this outbreak of typhoid fever is to be explained in some other way than by attributing it to a contaminated water supply, but when we bear in mind that, out of this group of closely situated cities and towns, all of those which used the Mohawk-Hudson water contracted the fever, and that all those which did not use such water escaped, there is much food for thought.

RENSSELAER POLYTECHNIC INSTITUTE,
TROY, N. Y., May 18, 1891.

THE USE OF CADMIUM IN ASSAYING GOLD BULLION.

BY CABELL WHITEHEAD, Assayer to the Mint Bureau.

[*Presented at the stated meeting of the Chemical Section, held Sept. 15, 1891.*]

Cadmium, as a substitute for silver in assaying gold bullion, was first used by Balling.* He states that the gold is entirely parted from all metals, except the platinum group, when its alloy with cadmium is boiled with strong nitric acid for one hour, followed by a second boiling for ten minutes with fresh portion of same acid. For general assays of gold bullion I do not think that Balling's method with cadmium will bear comparison in point of accuracy with the old one of quartation with silver and cupellation. But, with certain modifications which will be suggested later, it will be found rapid and satisfactory for a preliminary assay.

It is, however, in the estimation of small quantities of silver in gold bullion containing considerable amounts of copper or platinum, that I have found cadmium to be a most efficient aid.

---

* *Crook's Select Methods of Chemical Analysis.*

The difficulty in determining silver in the presence of platinum by cupellation is well known to assayers. In such cases the following has been the method in the United States Mint at Philadelphia:

An approximate assay is made by cupellation, after which, and based on this approximation, enough pure silver is added to 500 mgs. of the bullion to make in all at least 1,004 mgs. of silver present in the assay. This weighed silver and bullion is wrapped in a sheet of lead weighing 2·5 gms., and the whole placed on a hot cupel in the muffle furnace.

As soon as the lead "clears" the cupel is withdrawn, when cold the button is flattened and put in a bottle such as is used in the humid assay of silver, dilute nitric acid is added and heat applied. When action ceases, the silver present in solution is determined volumetrically as usual. The silver found, less the amount added, gives the silver in 500 mgs. of bullion.

There are two objections to this method: (1) The insolubility of lead nitrate in nitric acid necessitates the use of dilute acid, which leaves much alloy with the gold; (2) the alloy to be removed is one-third silver. This is very important when small quantities of silver are to be determined, as in the case of gold coin, which rarely contains more than ·003. Cornets, after three boilings with acid (ten minutes each), retain from ·001 to ·002 of silver; so it will be seen at a glance that the amount retained after one boiling with dilute acid will be much greater and the gold residue will contain more silver than was present in the original bullion.

The presence of ten per cent. or more of copper in high grade gold bullion makes the accurate determination of silver by cupellation impossible. Not only is gold taken into the cupel in large quantities by the copper, but it is also left in specks over the entire surface covered by the assay, thus making a "proof" practically worthless.

The method which I am about to describe, was devised for the estimation of silver in gold coin, and has been in use in the laboratory of the Bureau of the Mint for the past year, where it has given such satisfactory results that it is thought a brief description may prove of interest to others engaged in the same line of work.

Five hundred mgs. are weighed into a porcelain crucible and covered with ten gms. of potassium cyanide. The potassium cyanide is melted over a Bunsen burner or preferably a blast lamp. When the cyanide is in quiet fusion one gm. of cadmium is dropped into the crucible, where it quickly melts and forms a bright, homogeneous alloy with the gold. After gently shaking, so as to bring the cadmium in contact with every particle of bullion, the crucible is removed and the contents poured on a clean porcelain slab, where it soon solidifies. The alloy will be found in one piece and is easily detached from the potassium cyanide. It is now washed in warm water, dried and placed in a diamond mortar, when several sharp blows with a hammer quickly reduce it to powder.

This powder is carefully transferred to an assay bottle, 1004 mgs. of pure silver added and 10 cc. of nitric acid—32° Baumé—poured on. In from five to ten minutes (depending upon the heat used) the solution is complete and all action has ceased. The bottle is now cooled and 100 cc. of normal salt solution is charged and the bottle shaken. The precipitation is finished with the decinormal solution.

This assay is accompanied by another called a "proof," made of 1004 mgs. of pure silver dissolved in the same amount of acid. Now the excess of silver found in the assay over that shown in the "proof," is the amount contained in 500 mgs. of coin. This doubled gives parts of silver per thousand.

Example: An alloy composed of 499 mgs. pure gold, one mg. of silver and one gm. of cadmium, treated as above described, after being charged with 100 cc. normal salt solution, required five cc. decinormal solution for complete precipitation of the silver present. A proof assay, carried along as check, upon 1004 mgs. of pure silver, required in addition to 100 cc. of normal salt solution, four cc. of decinormal solution for complete precipitation = to 1004 cc.

decinormal solution. Hence, each cc. decinormal equals one mg. silver, and one cc. decinormal solution required by the bullion, in excess of that called for by the silver added, shows the bullion to contain one mg. silver in 500, or two parts per thousand.

It may be asked by those not familiar with mint appliances and usages, "Why not titrate directly the silver brought into solution with the cadmium instead of adding a known weight of pure silver and finding the desired result by difference?"

The reply is that the small amount of silver present in this class of bullion would, as chloride, not "clear" on shaking, and much time would be consumed in finding the end reaction. By the method described the usual apparatus and solutions may be availed of and results rapidly obtained.

When no such reasons exist the sulpho-cyanide method alluded to at the end of this article is recommended.

EXAMPLE IN GOLD BULLION.

An approximate assay gives by cupellation ·035 silver, hence, 500 mgs. will contain about 17·5 mgs. of that metal, and 986·5 mgs. must be added to bring the total silver up to 1004 mgs. If copper is not present, about 50 mgs. is added, it being found that the alloy of copper with cadmium is very brittle, and the resulting button is easily crushed to powder.

The sample having been fused with cadmium in presence of potassium cyanide is powdered and subjected to treatment with nitric acid as above described.

After charging with 100 cc. normal salt solution, and shaking, the assay required 4·5 cc. decinormal solution for end reaction. A "proof" consisting of 1004 mgs. pure silver in solution, treated in same manner, required but three cc. decinormal solution.

Hence the assay contained 4·5 — 3 = 1·5 mgs. more silver than the proof, or 1004 + 1·5 = 1005·5 mgs. in silver in all. This, less the 986·5 mgs. silver purposely added gives nineteen mgs. as the silver present in 500 mgs. of bullion taken, or thirty-eight parts in each thousand instead of thirty-five parts found by cupellation.

In favor of the new method it may be said:

(1) That the ready solubility of cadmium in nitric acid of any strength, makes it possible to dilute (if the term may be used), the silver present in gold bullion, to any desired extent, while on the other hand the difficult solubility of lead necessarily limits the dilution possible by the time required for its even imperfect extraction.

The inevitable small portion of other metals retained by the gold after treatment with nitric acid may therefore, by the use of cadmium, be made to contain but an infinitesimal quantity of silver.

(2) The brittleness of the button obtained, permits its being crushed to a powder, in which condition the alloy rapidly yields its soluble portion to nitric acid, and the time required for an assay is materially shortened.

(3) The low temperature required enables the chemist to dispense with all special appliances. A Bunsen burner will well answer the requirements for heating purposes, and little more is needed beyond a standard salt solution. No muffle or rolls are wanted.

In a laboratory where few assays are made the following method might be followed and very satisfactory results obtained. After alloying and crushing, treat in a parting flask with fifteen cc. of nitric acid 32° Baumé for ten minutes, pour off this acid into a beaker, add fifteen cc. acid same strength and boil for ten minutes longer, pour off again in same beaker, wash with hot water and take out in an annealing cup, dry and heat over blast lamp, weigh and deduct ·25 mgs. for cadmium retained. Twice this weight gives the gold fineness.

The acid and washings are evaporated to drive off free nitric acid, and silver determined either as chloride, or volumetrically with sulpho-cyanide with ferric indicator. Cadmium nitrate does not interfere in the least with determination of silver, either as chloride or as sulpho-cyanide.

"PRESERVALINE," A NEW PRESERVATIVE FOR MEAT.

BY DR. BRUNO TERNE.

[*Read at the stated meeting of the Chemical Section, held May 19, 1891.*]

Some time ago, I was applied to for information as to how to pickle meat without the use of nitrate of potash or saltpetre. The objections to the use of saltpetre are said to be:

(1) The operation of curing takes too long a time.

(2) It renders the outside of the meat hard.

"There is a compound," my inquirer said, "that is used in large quantities in the West, and which avoids both these objections. What is it?"

I informed him that if he would procure me a sample of this material, or would, in lieu of this, furnish me either with a specimen of meat prepared with it, or with some of the pickle as prepared for use, I might be able to throw some light upon the subject.

Shortly after this, I came into possession of two samples both in pulverulent form, one red and the other white in color. I exhibit specimens of both of these preparations. From another source I learned that this product was placed on the market under the trade name of "Preservaline."

A qualitative test showed conclusively the absence of all nitrates and the presence of boracic acid in combination with a base, for the reason that the characteristic green coloration of the flame only appeared after the addition of a drop of sulphuric acid. It appeared further that both the red and white samples had the same composition, with the sole difference that to the colored sample there had evidently been added some rosanilin color.

I made up a sample with a little rosalic acid which exhibited nearly the same color as the original one but a little more pronounced.

The quantitative analysis of the white sample gave:

	Per Cent.
Biborate of sodium,	44·18
Chloride of sodium,	45·30
Moisture,	7·80
Impurities (undetermined),	2·82
	100·00

Practically then, we have here a mixture of equal parts of borax and common salt and the "Regular" preservaline, which imparts to the meat a cherry-red color, as per announcement of the manufacturers and vendors of this article, is simply the same product, with the addition of some coloring matter or dye.

I was aware that the use of coloring matters was largely employed in certain articles of food, especially in all candies and cakes, and the like, but it was somewhat of a surprise to learn that enterprise in this direction had progressed so far as to impose dyed meat upon us.

I investigated the red sample for traces of arsenic, which possibly might be contained in the color, but I am glad to report that I found none.

The solution of both samples was strongly alkaline. Without any doubt, this product, on account of the large quantity of borax in its composition, will act as a good preservative, but it is unquestionably a fraud upon the public, so far as the selling price is concerned, as the following statement will show:

	Cents.
One pound of borax is worth	9
" " " salt " "	1½
Two " " mixed salt is worth	10½
One " " " " " "	5¼

It is put upon the market for the prices indicated in the following tabulation, reproduced from the manufacturer's circular:

"REGULAR."

For Curing Pork and Beef.	*Per Pound.* *Cents.*
In barrels,	14
100 lb. kegs,	15
50 lb. drums,	16
25 lb. drums,	16
10 lb. box,	16

Use one pound for every 100 pounds of meat.

This preservaline gives the meat a cherry-red color.

"A."

For Pork and Liver Sausage.	*Per Pound.* *Cents.*
In barrels,	24
100 lb. kegs,	25
50 lb. drums,	26
25 lb. drums,	26
10 lb. box,	26

Sprinkle one-half pound over every 100 pounds of meat while being chopped or mixed.

"B."

For Bologna and Smoked Sausage.	*Per Pound.* *Cents.*
In barrels,	16
100 lb. kegs,	17
50 lb. drums,	18
25 lb. drums,	18
10 lb. box,	18

Use one pound for every 100 pounds of meat.

Preservaline prevents any kind of sausage from turning sour, even in the warmest weather, and retains the natural color of the sausage.

Looking over the literature of the subject, I found that a series of investigations of similar products had been made by Mr. G. Polenski, (*vide Reports of the Imperial German Health Office*, 1889, No. 5, p. 364).

I quote therefrom the following data, respecting the composition of a number of such materials.

(1) THE REAL AUSTRALIAN MEAT PRESERVER.

(A nearly colorless liquid, emitting a strong odor of sulphurous acid.) It contains in one litre:

	Grams.
Calcium oxide,	11·08
Sulphurous acid,	46·03
Ferric oxide (alumina),	·039
Silicic acid,	·052

(2) REAL AMERICAN MEAT PRESERVER.

(The same liquid, but a stronger solution.) Contains per litre:

	Grams.
Calcium oxide,	26·42
Sulphurous acid,	89·60
Ferric oxide (alumina),	1·80
Silicic acid, and alkalies,	1·20

(3) CONSERVATIVE FOR SAUSAGES.

(The same liquid, slightly opaque, but odorless.) Contains per litre:

	Grams.
Saltpetre,	33·40
Boracic acid,	27·50
Glycerine,	50·00

(4) PRESERVING SALT OF R. LEISENTHAL, COLOGNE.

(Does not redden the meat.)

Borax,	48·40
Water of crystallization,	39·00
Common salt,	3·44
Sodium bicarbonate,	9·10

(5) PRESERVING SALT OF THE SAME MANUFACTURER (TO MAKE THE MEAT RED).

	Per Cent.
Boracic acid,	28·34
Common salt,	9·58
Saltpetre,	57·35
Water,	4·50

(6) PRESERVING SALT OF GAASE BROS., BERLIN.

	Per Cent.
Boracic acid,	29·70
Saltpetre,	37·80
Common salt,	26·70
Water,	5·80

(7) AMERICAN HAM PRESERVER.

(An acid, yellowish liquid, having an empyreumatic odor.) Contains per litre:

	Grams.
Potash alum,	70·
Saltpetre,	21·04

(8) STUTTGART CONSERVING LIQUID FOR MEAT.

(An acid liquid, having a strong sulphurous acid odor and a yellowish color.) Contains per litre:

	Grams.
Arsenious acid (As_2O_3),	0·103
Common salt,	5·500
Phosphate of lime ($Ca_3(PO_4)_2$),	41·940
Sesquioxide of iron and alumina,	0·440
Sulphurous acid,	37·440
Free phosphoric acid (H_3PO_4),	6·050

9. SIMPLE CONSERVING SALT, OF CONSERVING SALT CO., HAGEN.

(A white salt, in solution, alkaline.) Contains:

	Per Cent.
Borax,	21·95
Water of crystallization,	13·30
Saltpetre,	33·10
Common salt,	32·04

10. TRIPLE CONSERVING SALT OF THE SAME MANUFACTURER.

	Per Cent.
Salt,	0·80
Boracic acid,	55·50
Borax,	29·00
Water of crystallization,	14·70

11. SAZOLITH.

	Per Cent.
Sulphate of soda,	37·3
Sulphurous acid,	39·7
Soda,	21·0
Water,	2·00

12. BERLINIT.

	Per Cent.
Common salt,	7·5
Boracic acid,	9·
Borax,	82·7

BERLINIT PICKLE (for reddening the meat).

	Per Cent.
Salt,	45·9
Saltpetre,	32·2
Boracic acid,	19·2
Water,	2·0

13. CHINA PRESERVING POWDER. (MINERVA.)

	Per Cent.
Common salt,	25·00
Boracic acid,	17·7
Sulphate of sodium,	38·8
Sulphite of sodium,	9·2
Water,	9·3

14. AUSTRALIAN SALT.

	Per Cent.
Common salt,	5·5
Borax,	94·00
Hydrocarbon (?),	0·5

15. DR. C. RUEGER'S BARMENIT.

Equal parts of borax and common salt.

This last brings us home again. American ingenuity, it will be perceived, is again in the lead. All the liquids and powders here referred to are free from coloring matter. They all use saltpetre to impart the red color to the meat, but the inventor of preservaline introduces the novelty of a dye to take its place.

The directions given by the manufacturer for the use of the red "regular" for curing pork and beef, prescribe one pound for every 100 pounds of meat. This is equal to one-half per cent. of borax.

The prescription for the white, for curing bologna and smoked sausages, indicates the same quantity.

We have no positive knowledge of the action of large quantities of borax upon the human organism, when taken internally, though there can hardly be any doubt that if taken even in small doses continuously for a considerable time its effect must be hurtful. This question, however, I leave to the decision of others better qualified for passing judgment upon it than myself. It was simply my intention to call to your notice the common use of borax as a preservative for meat, and especially the misuse of anilin red to replace in such mixtures the use of saltpetre.

THE UTILIZATION OF THE BYE-PRODUCTS OF THE COKE INDUSTRY.

BY DR. BRUNO TERNE.

[*Read at the stated meeting of the Chemical Section, held Oct. 20, 1891.*]

About a year ago I had the honor to speak in the lecture course of the Franklin Institute on ammonia, its sources and technical uses.

I dwelt for reasons which I thought of sufficient importance, especially on the production of ammonia as a bye-product of the coke industry.

We have now entered upon the beneficial workings of the new policy of furthering industrial developments in new branches in a period which requires the technical men in all branches, and especially in the chemical industries, to call the attention of the capitalist to the points in which we are behind the times in our developments, to the points where the resources of our own land are neglected, and we are far behind the more progressive European manufacturers.

I thought it of sufficient importance to ventilate the same question before the Chemical Section of the Institute in order to create an interest in the circle of the members of the Institute, who are the best judges of such questions, in order to provoke criticism of my views.

I have revised the part of my lecture referring to the development of the ammonia industry for this purpose, not in the expectations of claiming new and original ideas, but to secure your attention to a point which I consider of great importance for the development of an important branch of the chemical industries.

We are surrounded by an immeasurable quantity of nitrogen gas in the atmospheric air.

The weight of the atmosphere surrounding our earth is calculated to be ten trillions of pounds, of which 7·77 trillions pounds are nitrogen; but in spite of this inexhaustible source of nitrogen, we are not able in a direct way to use a single pound for the production of ammonia.

It has long been the endeavor of the technical chemist to convert the nitrogen of the air into ammonia, but up to this hour none have succeeded in doing it with practical results. We are still compelled to use as sources for the production of ammonia, the products of plant or animal life.

The nitrogen of the air must pass through the channels of plant life to reach in the products of the animal body their highest degree of concentration.

Hoofs and horns with fifteen to sixteen per cent. dried blood, with nineteen per cent. hair and wool waste, with ten per cent. bones, with five per cent. of ammonia, are the richest sources.

But the products of animal life, however, even if they were not too valuable otherwise, are by no means sufficient to satisfy the wants of the present day for the products of ammonia. But Nature has provided an inexhaustible source for hundreds of years to come, in the residuum of plant life of former periods. In the bituminous coal fields and in the deposits of brown coal are lying stored up, billions of pounds of nitrogen waiting to be converted into ammonia.

The process of gaining this ammonia is incidental to the production of illuminating gas, to the production of coke, and to the production of animal charcoal.

In distilling the bituminous coal we obtain of the weight of coal used:

4-6 per cent. of tar and 6–10 per cent. of ammoniacal water of 1°·8 B.

As Prof. Lunge has shown, the nitrogen contained in the coal does not yield the amount of ammonia which we might expect:

Name of Coal.	*Yield of Nitrogen. Per Cent.*	*Possible Yield of Ammonia. Per Cent.*	*Possible Yield Ammonia Water. 1·020 spec. grav. Per Ton of Coal. Gallons.*
Wales,	0·71	1·10	142
Lancashire,	1·25	1·52	196
Newcastle,	1·32	1·60	206
Scotland,	1·44	1·75	226

But instead of these figures, the practical yield per ton of coal at the best is only forty-five gallons of gas water of 1·020 sp. gr., generally only twenty-five gallons, and in some instances, as low as thirteen gallons.

The ammoniacal liquors from distillation of animal refuse are much richer, but the small quantity produced allows us to ignore the same as a very insignificant factor in the production of ammonia salts.

The consumption of ammonia in its various forms has grown enormously in the last twenty years, and the manufacture of illuminating gas is no longer sufficient to supply the increasing demand for ammoniacal liquors. On the other hand the inroad which electrical plants for illumination have been making yearly on the production of illuminating gas, has already been felt, and will be more so from year to year. The production of water gas and oil gas are other factors which are cutting down the amount of ammoniacal waters produced.

But there is another source for tar and ammonia, which, so far as my knowledge goes, has, with a single exception, not been worked in our country.

Rich as are our resources, we are not rich enough to waste continually.

It seems strange, and nevertheless it is a fact, with all the ingenuity of the American people in the advancement of the purely mechanical part of the technical industries, we have been and are yet slow in the development of the chemical industries.

The acid manufacturer of Europe, especially of England

and Germany, had commenced in the beginning of this century to make himself independent of the sulphur mines of Sicily by using the sulphurous ores of his immediate neighborhood, and to utilize the pyrites for making his sulphuric acid. It has been only within the last twenty years that our people commenced to use the ores which had been lying under their feet, and to-day even, the United States consumes more sulphur for the manufacture of sulphuric acid than any other nation.

It is the same with productions of tar and ammonia as a bye-product of the manufactures of coke.

If you will visit our coal region to-day, you will find the nightly sky illumined from the fires of the coke ovens, and every one of the brilliant fires bears testimony that we are wasting the richness of our land in order to pay the wiser European coke manufacturer, who saves his ammonia and sends it to us in the form of sulphate of ammonia; and who also saves his tar, which, after passing through the complex processes of modern organic chemistry, reaches our shores in the form of aniline dyes, saccharin, nitrobenzol, etc.

As far back as 1768 tar had been produced as a bye-product of the coke industry by a chemical process at Fishbach, in the coal district of Soarbrücken on the Rhineland.

The general opinion of the consumer there was then, and most likely will be here at the present time, that the coke produced will be of inferior quality. Against this opinion of the practical coke men, it has always been held by technical chemists, that the process can be so conducted as to yield all the bye-product and still make a first-class coke.

Since about 1850, the producers of coke in France, Belgium, England and Germany commenced simultaneously the saving of the bye-products.

At St. Etienne, in France, a system of furnaces was at work in 1862 for which great success was claimed at that time. The gas and other volatile products of the coke oven were conducted to an air condenser, in which the tar and ammonia were condensed; the non-condensable gases were returned to the furnace as fuel.

Scrubbers and condensers have been improved to insure complete condensation.

The following average results have been claimed:

	Per Cent.
Coarse coke,	70
Small coke,	1½
Waste coke,	2½
Graphite,	½
Tars,	4
Ammonia water,	9
Gas,	10·58
Loss,	1·92

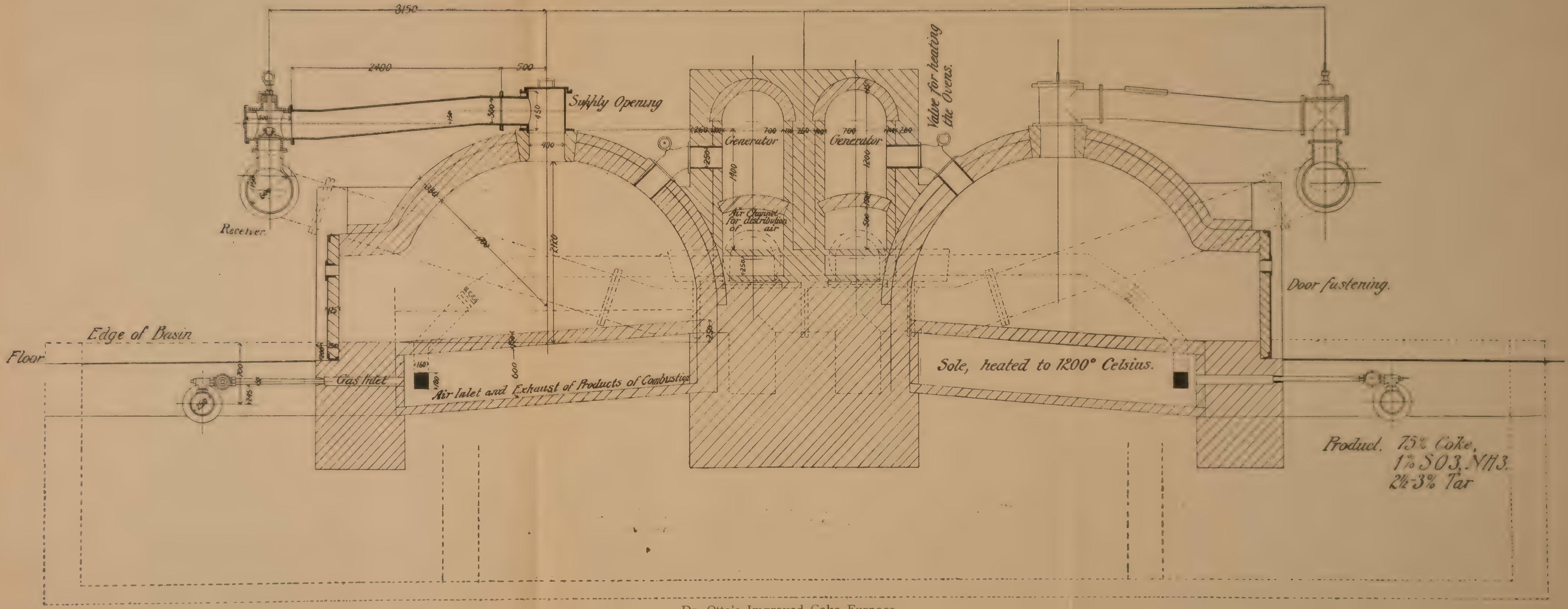
The net gain after deducting all expenses and without reckoning in the coke was, per oven, in Bessèges which has eighty-five ovens in operation, 111,446 francs. For eighty-five ovens this saving amounts to 94,690 francs or about $18,938.

I give you in the accompanying table, the results reported from two establishments in France.

I will not endeavor to cover the development of the coke industries of Europe for the whole period since 1850. I have had occasion to familiarize myself with all the conditions of this industry, and am in possession of figures and plans of Dr. Otto's successful ovens, a view of which I show you. (See accompanying plate.)

In 1883, a system of twenty ovens were built at the coke works of Gottesberg, Silesia, the results from which were so encouraging, that in the following year 120 ovens were built.

I will give you a report from a manufacturer, who, two summers ago, visited the Dahlhausen works of Dr. Otto, at the mines of Millensiven near Dortmund. Here, there are two sets of thirty ovens each, which are charged alternately every other day. The gases are conducted by large iron pipes to a large basin, where a part of the tar will be condensed. From there it is led to the coolers, where the remaining tar and ammoniacal products are absorbed, and the gas purified is returned to a gas holder, and from there is redistributed to the coke ovens, to the boiler fires and utilized as illuminating gas throughout the works. The gas returning to the coke ovens is mixed with hot air, and enters the flues


3150
2400
500
Supply Opening
450
400
300
Receiver.
2120
Edge of Basin
Floor
Gas Inlet
160
180
600
Air Inlet and Exhaust of Products of Combustion
260
100
700
250
Generator
1400
1200
Air Channel for distribution of air
500
Valve for heating the Ovens.
Door fastening.
Sole, heated to 1200° Celsius.
Product. 75% Coke, 1% SO3, NH3. 2½-3% Tar

Dr. Otto's Improved Coke Furnace.

of the bottom and sides. The coke produced is an excellent product, and finds a ready market everywhere. It has not the silver gray or steel color of our Connellsville coke, but it is quite as good in quality as ours.

NAME OF WORKS.	Number of Ovens.	Tons of Coal Consumed.	YIELD OF COKE.			TAR.			AMMONIA WATER.		SULPHATE OF AMMONIA.		
			Total Tons.	Prac. Per Cent.	Per Oven.	Total Tons.	Per Cent.	Per Oven.	Hectolitres.	Per cent.	Per Hectolitre. Kilograms.	Per Oven. Tons.	Per Ton of Coal Kilograms.
1879.													
Bességes, ...	85	46,902	33,092	70·55	389·3	1,096	2·23	12·89	44,932	9·6	6·5	3,435	6·22
Terrenoire, April 1 to December 31, 1879, . .	100	38,427	26,293	68·42	—	966	2·50	—	36,205	9·72	7·6	—	—
Per annum calculated, .	—	—	—	—	350·57	1,288	—	12·88	—	—	—	3,374	6·54

The person who pronounces this verdict was then, and is now, connected with one of the largest iron works of our state, and thoroughly well informed upon every point of blast furnace produce, and familiar with the qualities of coke produced and used in the Connellsville region.

He repeated, after having explained to me how even the same color could be made, that the quality of this coke is in every respect equal to that of Connellsville. "But," he added, "I desire to call your special attention to the statement, 'The oven of Dr. Otto yields seventy to eighty per cent. of coke, while our Connellsville 'Beehive' oven will only yield fifty-five to sixty per cent.'"

Dr. Otto builds these ovens at his own expense, runs them for twelve years, taking the coal from the mines and delivering the coke to the mine company, for the yield of tar and ammonia, and at the end of the term surrenders the whole plant to the mine owners. He must make in this time from the value of the bye-products alone, the cost of the ovens, the interest of the capital invested and the legitimate profit of a manufacturer, and he is successful in doing it. Don't you think that we can achieve the same results here?

In the year 1887, there were in operation in 279 establishments in the United States, 26,001 ovens, and 3,594 ovens in course of erection.

These ovens consumed 11,859,753 tons of coal, producing 7,611,705 tons of coke, a percentage of 64·2. Calculated on the basis given in the table before you, the possible yield of sulphate of ammonia from this quantity of coal, *i. e.*, 12·8 pounds per ton, will give us the enormous figures of 151,804,838 pounds of sulphate of ammonia, which at three cents per pound only is equal to $4,554,746.

Pennsylvania is the principal coke-producing State in the Union.

Seventy-six and six-tenths of the coke used in the United States is made within her borders.

The number of establishments were, in 1887, 151, with 18,294 ovens, which produced 5,872,847 tons of coke, a yield of sixty-five per cent. The Connellsville district, of Pennsylvania, is one of the most important of the world. The Connellsville basin is in the southwestern part of the State, some fifty or sixty miles from Pittsburgh. In this district were made 4,146,989 tons of coke, or 57·4 per cent. of all the coke made in the States.

At three works, during the year 1886, careful weighings were carried on, with the following results:

	Coal Charged.	*Coke Produced.*	*Per Cent. Yield.*
No. 1,	230,585	157,070,40	68,118
" 2,	60,934	40,947,09	67,188
" 3,	63,893·2	42,927,24	67·2
Total,	355,421·2	240,944,64	67·8

The coal used in Pennsylvania in 1887, for making coke, was 8,938,849 short tons.

If this had been done, with saving of the bye-products, 178,776 tons of tar and 114,417,267 pounds of sulphate of ammonia, or 7,208 $\frac{1267}{2000}$ tons of sulphate of ammonia could have been produced, which represents in ammonia salt alone a value of \$3,432,480; or, to illustrate in another way, 28,604,316 pounds of ammonia, which has an agricultural valuation of eighteeen cents per pound, have been lost to the industrial and agricultural interests; or, at the valuation of the agricultural experimental stations, the loss of a single year was $\$5,128,776\frac{88}{100}$.

I am very well aware that these figures are imaginary, as under the best possible circumstances not all the coke ovens could readily be arranged for the saving of bye-products but if one-eighth or one-half of the total production were united with saving of the bye-products, from one to two millions a year on ammonia only could be produced in this State alone.

You will ask, Will the Connellsville coal give the same result as the German coal? Without hesitation, I answer, it will.

There are here five samples of coal from the Connellsville district, which have been analyzed in my laboratory, with the results given below:

	Per Cent.	
No. 1,	1·76	ammonia.
" 2,	1·26	"
" 3,	1·90	"
" 4,	1·80	"
" 5,	1·80	"

These analytical results place the coal of the Connellsville region on an even footing with the bituminous coal of the district, where the bye-products of coal are gained in making coke.

There are numerous systems of coke ovens in Europe, but none has been more successful than the ovens mentioned above. Whatever the system may be, the products of condensation must be separated; the tar from the ammoniacal waters, and each worked according to its specific requirements. In England, the escaping gases of blast furnaces have in two instances been worked for ammonia. I am unable, however, to say anything about results.

The interest of the manufacture of ammonia requires that the liquors should be as concentrated as possible, and still leaving the gases escape as free as possible from ammonia. To accomplish this, certain improvements in apparatus have come into use. The older construction of scrubbers, or apparatus for washing the gases, has been superseded by mechanical scrubbers. One of the latest constructions of such a scrubber is the one represented in the accompanying illustration. It is the form constructed by the Director of the City Gas Works, in Chemnitz, Saxony, and adopted by the best authorities of Germany as one of the most economical working forms of the apparatus.

The mechanical scrubber of E. Ledig* is based on the principle of the rapid absorption of ammonia by water distributed over a large surface, which is heated by a system of plates alternately dipping in water and raised out again, thus offering the gas the large surface of the combined plates. This up and down movement creates new surfaces for absorption with each motion, and secures a complete washing of the gas. The ammoniacal liquor so gained has now to be worked so as to gain the ammonia from it in order to prepare the different ammonia compounds.

The ammoniacal liquors contain free ammonia, carbonate of ammonia, sulphide of ammonium, sulphocyanide of ammonium, tartrate of ammonia, sulphite of ammonia, chloride of ammonium, sulphate of ammonia, organic ammonia compounds, such as amin, pyridin, etc.

---

* U. S. Patent, No. 407,937, July 30, 1889.

The ammonia waters contain in one litre, from coals of the

			Grammes.	
District	Zwickau	(Saxony),	37,943	ammonium salts.
"	Ruhr	(Rheinland),	29,402	
"	Saar	"	43,225	
"	"	"	9,506	

You will notice that the differences in yield are very wide, but nevertheless the smallest amount named is sufficient to make the gain, the bye-products, in the commercial scale, a profitable operation.

The oldest methods of gaining the ammonia were to saturate the liquors directly with sulphuric acid in large tanks. The cost of evaporating such enormous quantities of water and the impure condition of the product soon led to the invention of improved methods.

Tanks, or a system of tanks, were heated directly by fire or steam, and the volatile ammonia driven out to be absorbed by the acids in the receivers.

The newest improved forms of apparatus are those constructed by the well-known manufacturer of chemical products, Dr. Grüneberg, of Cologne, and by Dr. Feldmann, of Bremen. Both of these are constructed on the same principle, viz: a current of steam moves in opposition to the movement of the liquor. The richest liquor comes in contact with the nearly saturated vapors and the weakest liquor with the fresh steam.

These forms of apparatus have superseded in Europe, especially in England and Germany, the older devices.

The accompanying engraving (*Fig. 1*) shows the construction of the Grüneberg apparatus.

The apparatus of Dr. Feldmann is still simpler and is, therefore, preferred by a great many manufacturers of ammonia salts. (*Fig. 2.*) Both of these devices are patented in the United States.

The Feldmann apparatus cannot be excelled for economy of steam and reliability in service; its capacity for working five to twenty-five tons of liquor daily makes it likewise desirable for a rural gas works as well as large establishments.

The question, "Will it pay to gain the bye-products of the manufacture of coke?" has been practically solved in the affirmative. The numerous objections have, step by step, been overcome. The industry of the coke production combined with the saving of the bye-products is an established fact in Europe, and will be here also in the near future. What system of ovens will be found best adapted to our wants, may be an open question to decide, which rightly will require the consideration of a great many points of local importance.

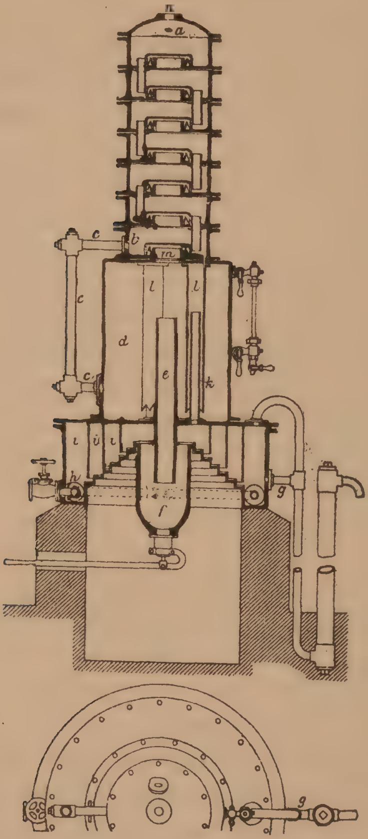


FIG. 1.—The Grüneberg Ammonia Still.

The system which I have described is one of the most successful of those used in Germany to-day.*

I advocate the Otto system because I know of its merits and advantages from a careful study of it, and lengthy correspondence with the inventor.

The results obtained by Dr. Otto, Copper and others, exhibit such decided progress over the past, that it is only a question of time when the coke producers of the United States must fall in line.

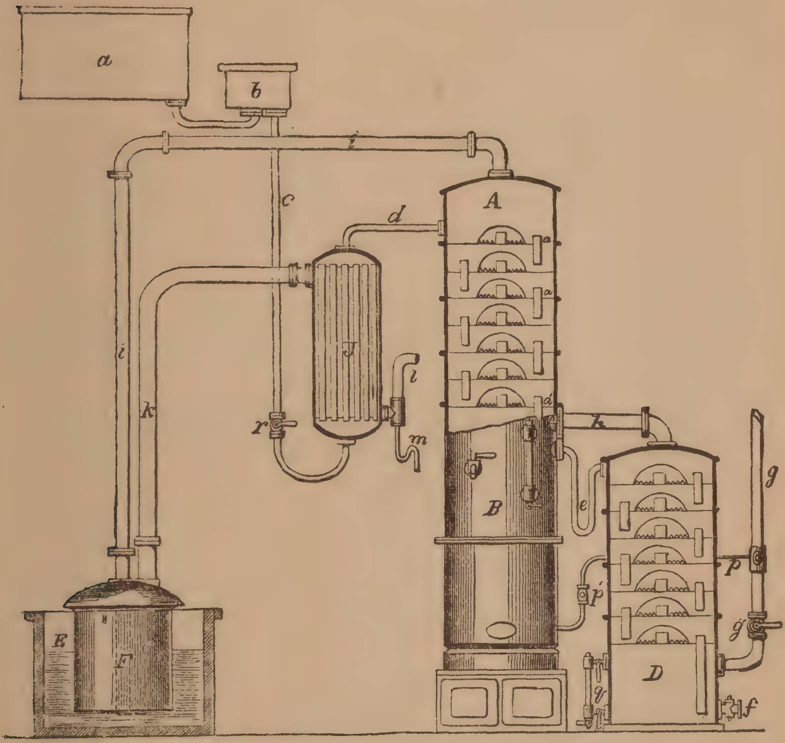


FIG. 2.—The Feldmann Ammonia Still.

The advance in the coke industry will cause an advance in the tar color industry, and will further the growth of the soda industry based on the ammonia process.

---

* The latest improvements are covered by D. R. P. 52,206, Universal coke-oven, C. Otto and F. W. Larmann.

If I have succeeded in adequately exhibiting the importance of saving the valuable products at present wasted in our coke industries, I shall have accomplished my purpose.

Until every pound of ammonia used in our land is produced in our land, until every pound of soda is made from our own salt wells by the ammonia process, we will continue to be dependent upon the chemical markets of Liverpool and London.

DISCUSSION.

Dr. H. W. JAYNE: No one will deny the importance of the subject presented to us this evening by Dr. Terne, and I am aware that it has been carefully investigated by a number of large firms in the country, but as yet nothing has been done.

Coke operators fear that it would be difficult to overcome the prejudice against the coke as it has not the silvery appearance of the Connellsville article.

The great first cost of the plant is another serious obstacle. An ordinary beehive oven to work about 480 tons per year costs about $280, while a Carves oven of the same capacity costs complete with the coolers and all appliances $845 each, and Otto ovens of 1,000 tons capacity would cost $750 for ovens, and $1,450 for coolers and all other machinery and buildings. The above figures were furnished by the respective inventors.

In addition, the present beehive oven is of extremely simple construction, and can be run by the most unskilled labor, while the improved ovens are complicated and require nice working and constant repairs to prevent loss of gas, and consequent loss of the bye-products.

There can be no doubt that eventually such ovens will be introduced, and when in successful operation, other coke producers will be compelled to erect them, as they could not possibly stand the competition caused by ovens producing not only such valuable bye-products, but also such a greatly increased yield of coke.

Dr. TERNE said: I would like to state, that according to Dr. Otto's figures in my hand, the cost per oven, without condensation apparatus, is 1,508 marks ($377.) Or, for a battery of thirty-eight ovens, with complete condensation apparatus:

(I) 38 ovens,	57,304 marks.
Condensation apparatus,	117,683 "
	174,987 "
Equal to,	$43,746 75
Or, per oven,	1,151 20

It is well to state here that the apparatus of condensation for the winning of the bye-products will outlast the life of the ovens many times; the first cost will, therefore, be limited to the first system erected.

Mr. HENRY BOWER referred to a short article which he had recently seen in the *Chemical Trades Journal* of Manchester, England, in which it was stated that it was not certain whether certain firms of speculators were not contributing to the depression in the prices of anthracene and benzole in the hope of frightening investors from opening additional carbonizing works. Mr. Bower also referred to the depression existing in the prices of sulphate of ammonia, and the influence of tar-producing concerns in Philadelphia against the carbonizing process.

Dr. JAYNE: The statement, referred to by Mr. Bower, which appeared in the *Chemical Trades Journal*, of Manchester, referred to the fact that the large production of benzole by the coke carbonizers prevented the extreme prices which would otherwise prevail owing to the great consumption of this article at present, especially in the preparation of medicinal articles.

Before the carbonizing plants were in operation benzole fluctuated very violently, ranging from thirty cents to $1.25 per gallon in one year.

The large amount of benzole produced by the coke plants is not obtained from the tar, which contains only a small quantity, but from the gases, which contain about twenty-five times as much as the tar.

In our cities it is impossible to remove this benzole from the gas, as it would at the same time remove most of the illuminating properties, but the coke gases can be cooled and washed with oils removing most of the benzole.

The inventors of the Simon-Carves oven claim that they can thus obtain three-fourths of a gallon of a high grade benzole from one ton of coal. It may be interesting to note in this connection that there are, or were, several plants running in England carbonizing coal in gas retorts entirely for the bye-products, as such coke is of little value. One of these works at the "Talk of the Hill" Collieries had 300 retorts in use producing 12,000 gallons of benzole per month.

Dr. TERNE: In reply to the remarks of Mr. H. Bower, I beg to say that the influence of the tar-producing companies of Philadelphia will not be dominant enough to prevent the development of this branch of chemical industries.

The combined interest of the larger producers and consumers of tar and ammonia will finally regulate the development of this industry.

To the further remarks of Mr. H. Bower, I should answer that I desire it distinctly to be understood that I do not advocate the producing of coke only for the gain of ammonia.

The higher yield of coke, the gain of the tar, with the daily increasing demand for same, and the gain of the ammoniacal water are the inducements which are given by the new methods.

The temporary depression in the price of sulphate of ammonia will not last, and even yet at ruling low prices we have not reached two and one-half cents per pound as on the other side.

We do not need to be frightened by wages; it will cost very little more to make coke and gain the bye-products than it now costs, and the slight additional cost will be amply repaid by the tar and ammoniacal water.

The cost of sulphuric acid does hardly come in play, first because we get a higher price for sulphate of ammonia produced, and second, we do not need to turn the ammonia in sulphate.

The ammonia soda industry of this country is in its infancy, and the demand of concentrated ammoniacal waters for the same will be steadily increasing.

The development of these industries is bound to come in spite of all objections, and it will be not so far off either. The right start is the most difficult point.

PROCEEDINGS.

[*Stated meeting held Tuesday, November 17, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, November 17, 1891.

Dr. W. H. WAHL, President, in the chair.

Nominations of officers to serve during the coming year were made, as required by the by-laws.

In the cases of President, Secretary, Treasurer and Conservator, the present incumbents, namely, Dr. Wm. H. Wahl, President and Conservator; Dr. Wm. C. Day, Secretary; Dr. H. W. Jayne, Treasurer, were re-nominated.

Dr. E. F. Smith and Dr. Wm. H. Greene were nominated as Vice-Presidents.

The following nominations for membership in the Section were made, viz: Mr. Geo. W. Whyte, of the Camden Iron Works, Camden, N. J.; Mr. Alfred N. Seal, 417 Locust Street, Philadelphia; Dr. Herbert M. Kaufmann, 1325 Franklin Street, Philadelphia, and Mr. S. W. Young, of Swarthmore College, Pa. These nominations were referred to the Committee on Admissions, by whom they were favorably considered, and the persons named were declared elected.

Letters of resignation from Mr. Everett W. Frazer, at present of New York City, and Mr. A. A. Moore, of the Franklin Sugar Refinery, Philadelphia, were read, and the resignations were accepted.

A letter from Mr. M. Carey Lea was read, transmitting to the Section the gift of a collection of his published papers on allotropic forms of silver and a set of specimens of the various modifications of the element which he had prepared. They were examined with much interest by the members present, and, on motion, the Secretary was directed to write Mr. Lea a letter of thanks, conveying the Section's appreciation of the gift.

A number of bills for subscription to journals and also for postage and expenses incurred in sending out notices, were referred to the Finance Committee; they were indorsed by the committee, and payment was authorized.

Mr. Lee K. Frankel read a paper "The Oxidation of the Metallic Arsenides by the Electric Current." The paper was listened to with interest, and was referred for publication in the *Journal*.

This was followed by one from Mr. Otto Lüthy, on "Carbonic Acid Determination." Specimens of potash pumice and other materials discussed in the paper were submitted for inspection. The paper was referred for publication, and the author stated that at the next meeting he would present the results of a further prosecution of the investigation.

Adjourned. WM. C. DAY, *Secretary*.

I. THE IODATION OF *p*-BROMOBENZOIC ACID.
II. SALTS OF *p*-BROMO-*m*-NITROBENZOIC ACID.

By OLIVER HOUGH.

[*Read at the stated meeting, held October 20, 1891.*]

It is stated by Weselsky (*Annalen*, **174**, 99) that the method of iodation recommended by him is not applicable in the case of bromobenzene, or benzoic acid. Believing that possibly a different result might be obtained with bromobenzoic acid, in which two hydrogen atoms are replaced by different substituents, the following experiments were made:

(1) Ten grams of *p*-bromobenzoic acid, dissolved in alcohol, were heated with the calculated amounts of iodine and mercuric oxide. The product was heated with an aqueous solution of sodium carbonate, and filtered while hot. Hydrochloric acid was added to the cold solution, and the liberated organic acid converted into its barium salt. Analysis showed it to be the barium salt of *p*-bromobenzoic acid. The iodation had not been effected.

(2) It was suggested that possibly the iodation had really occurred, but that the sodium carbonate had again removed the iodine. To ascertain whether such was really the case, the acid after treatment was digested immediately with barium carbonate. The resulting salt proved to be *p*-bromobenzoate of barium.

(3) A third experiment was equally fruitless. Finally, the *p*-bromo-acid, in alcoholic solution, was heated together with iodine and mercuric oxide, in a sealed tube. The temperature of the oven was 150° C. Iodine was not introduced into the acid even in this way.

II. SALTS OF *p*–BROMO—*m*–NITROBENZOIC ACID (m. p. 199° C.).

The known salts of this acid are those of barium, magnesium and silver. The following are new:

The *potassium salt* forms yellow-colored prismatic needles, varying in length from one-half to one inch. One hundred parts of water at 26° C. dissolve 33·44 parts of the salt. The salt is anhydrous.

The *sodium salt* crystallizes in needles. It contains one molecule of water of crystallization; 100 parts of water at 26° C. dissolve 16·01 parts of the salt.

The *ammonium salt* separates from aqueous solutions in anhydrous needles; 100 parts of water at 26° dissolve 12·22 parts of the salt.

The *strontium salt* consists of minute white needles. It contains three and one-half molecules of water of crystallization. Found 14·88 per cent. Sr instead of 15·10 per cent.; 100 parts of water at 26° dissolve 0·88 parts of the salt.

The *calcium salt* consists of white needles. The air-dried salt lost, when carefully heated in an air-bath at 160°, 30·25 per cent. of water, corresponding to thirteen molecules. Found 7·45 per cent. Ca instead of 7·54 per cent.; 100 parts of water at 26° dissolve 1·09 parts of the salt.

The *zinc salt* crystallizes in white needles; 100 parts of water at 24° C. dissolve 0·70 parts of the salt. The addition of zinc chloride to a solution of potassium nitrobromobenzoate, produced a white precipitate which crystallized from hot water in round, yellow-colored masses. Under the microscope these appeared to consist of bundles of little plates. An analysis of the salt showed it to be the basic zinc salt. It contains three molecules of water. Found zinc = 20·24 per cent. instead of 19·87 per cent.

The *mercury salt* is anhydrous and white in color; 100 parts of water at 26° dissolve 0·96 parts of the salt. Found Hg = 44·04 per cent. instead of 44·90 per cent.

The *nickel salt* crystallizes in light green colored crusts; 100 parts of water at 26° dissolve 1·47 parts of the salt. It contains two and one-half molecules of water.

The *cobalt salt* consists of pink needles. It contains three molecules of water; 100 parts of water at 26° C. dissolve 1·05 parts of the salt. Found 11·53 per cent. Co instead of 10·74 required.

I carried out the above work in the laboratory of Dr. Edgar F. Smith, University of Pennsylvania.

THE OXIDATION OF METALLIC ARSENIDES BY THE ELECTRIC CURRENT.

By Lee K. Frankel.

[*A paper read at the meeting, November 17, 1891.*]

The decomposition of minerals and their subsequent oxidation by means of the electric current is a product of very recent origin. By reference to the literature of the subject, it will be found that the first attempt in this direction was made by Dr. Smith, in a paper published in the *Proceedings of the Chemical Section of the Franklin Institute*, vol. i, p. 52, in which the author has successfully completed the decomposition of chalcopyrite and gives the results of some preliminary investigation on chromite.

In a later and more exhaustive paper in the same journal, Dr. Smith has published his researches on the decomposition of other sulphides, and has proven conclusively that oxidation by the electric current gives results as quantitatively correct as those obtained by any wet or fusion method. In a still later paper by the same author (*American Chemical Journal*, vol. 13, No. 6), experiments on various kinds of chromite, indicate that the decomposition of this mineral is complete, if the conditions prescribed are closely followed. At present this completes the literature of the subject, and judging from the success so far obtained, it was deemed advisable to attempt the oxidation of the metallic arsenides, with the hope that the result would be similarly fruitful. These results and the methods used for obtaining them will be found appended below.

The apparatus used for this purpose was the same as that described by Dr. Smith in the *Proceedings of the Chemical Section of the Franklin Institute*, vol. ii, p. 53, and the method of using it was also substantially the same. The current generated from four storage cells of the Julien type, was passed through the resistance frame, then through a Kohlrausch ampèremeter, and lastly up through the nickel crucible, the latter being in all cases the positive pole. As for the oxidations, the time required, the strength of current, etc., differed in each mineral respectively. For this reason no general plan can be prescribed, but the details of the work will be found for each mineral, under its respective heading.

Gersdorfite (*Ni.Fe.*),*As.S.*—The sample used for the decomposition came from Shladming. The method of procedure was as follows: In a nickel crucible $1\frac{1}{4}$ inches high and $1\frac{3}{8}$ inches wide, 25–30 grams of solid caustic potash were placed. The contents of the crucible were heated until fusion took place, and the gersdorfite then carefully added. A current registering one ampère was passed through the mass for twenty minutes, the crucible being the anode. Towards the end of the operation, the current was reversed for three minutes to remove any particles of mineral that might have been enclosed in the metal dedosited on the cathode. After breaking the current, the crucible was allowed to cool, then thoroughly disintegrated with water, and the resultant insoluble material (nickel and iron oxides) filtered off. The clear filtrate was acidulated with concentrated hydrochloric acid, and then made strongly alkaline with ammonium hydrate. The precipitate (silica and alumina from the caustic potash), which formed on the addition of the latter reagent, was filtered off, and magnesia solution added. The precipitate of magnesium ammonium arseniate, which formed after standing twelve hours, was filtered off, dissolved in dilute hydrochloric acid, re-precipitated with ammonium hydrate, filtered, dried, weighed and ignited in a platinum crucible, in the manner prescribed for this determination. The results obtained were as follows: (1) ·2777 gram of ore gave ·2853 gram of magnesium pyroarseniate = 49·73 per cent. arsenic; (2) ·1137 gram of ore gave ·1173 gram of magnesium pyroarseniate = 49·94 per cent. arsenic; (3) ·2548 gram of the ore was dissolved in nitric acid, evaporated to dryness, the residue taken up in hydrochloric acid, and the arsenic acid reduced with sulphurous acid. Hydrogen sulphide was then added, the resulting arsenious sulphide filtered off, dissolved in nitric acid, the solution made alkaline with ammonium hydrate, magnesia mixture added, and the arsenic determined as above; ·2617 gram of magnesium pyroarseniate was found = 49·72 per cent. arsenic.

The insoluble residue remaining after the fusion was dissolved in water, was treated with nitric acid and evaporated to dryness. Hydrochloric acid was then added, and hydrogen sulphide passed through the solution for several hours, without the formation of any precipitate of sulphide of arsenic, showing that the mineral must have been completely decomposed.

Niccolite ($Ni.As.$)—With this mineral, the attempt was made to see what effect currents of greater intensity would have on the decomposition. It was hoped that with a current of greater strength the decomposition could be effected in less time, but as will be seen, the results, as far as a diminution of the time limit is concerned, are practically negative.

Two samples of the finely ground niccolite were subjected to a current which varied from 1½ to 1¾ ampères, for twenty minutes, and without any reversal of the current, 25–30 grams of caustic potash being used. In both cases did the residues which remained after disintegrating the fused mass with water, show the presence of arsenic, on treating the residues with nitric acid, evaporating to dryness, and the subsequent addition of hydrochloric acid and hydrogen sulphide. The presence of arsenic in the residues is probably due to the fact that the greater strength of current used in the decomposition, deposits larger quantities of metallic nickel on the cathode, enclosing at the same time appreciable quantities of undecomposed mineral.

A much weaker current was now tried. Two samples of the mineral were subjected to a current of half an ampère for twenty minutes, 25–30 grams of caustic potash being used. The result was the same as in the previous case, arsenic being found in both of the residues.

The time limit was now extended with more satisfactory results, the manner of decomposition being as follows: A current of one ampère was allowed to pass through the fused mass for twenty-five minutes, the current passing up through the crucible. At the end of this time, the current was reversed for five minutes, to remove the metal and any undecomposed mineral that may have attached itself to the platinum wire. The subsequent operations of extracting the alkaline arseniate and weighing it as magnesium pyroarseniate, were similar to those already given under Gersdorfite, with the exception that instead of filtering the precipitation of magnesium ammonium arseniate through filter paper, and igniting it in a platinum crucible, the precipitate was filtered directly through a porcelain Gooch crucible, of the pattern recommended by Prof. Caldwell. Owing to the fine, granular condition of the precipitate, this requires some care, particularly if the filter pump be used. The best results were obtained by first placing a layer of glass wool in the crucible and covering this with a layer of asbestos. After filtering, the crucible with its contents was first dried on a hot plate until all moisture was removed, and then gradually heated over a Bunsen burner for an hour. In this time all the precipitate will be converted into magnesium pyroarseniate. It is hardly necessary to state that the flame from the burner should not be allowed to enter the crucible below, lest a partial reduction of the precipitate ensue. It was also found advisable to allow the crucibles to stand for twelve hours after ignition, since the constant change in temperature made appreciable differences in the weighings. The results were as follows; ·1209 gram of niccolite gave ·1301 gram of magnesium pyroarseniate = 52·09 per cent. arsenic; 0·1540 gram of niccolite gave 0·1672 gram of magnesium pyroarseniate = 52·55 per cent. arsenic.

The residues left after disintegrating the fusions gave no reactions for arsenic. They both had a peculiar crystalline appearance resembling minute plates. They dissolved in nitric acid without any evolution of nitrous fumes, and are probably oxide of nickel.

Another sample of the ore was dissolved in nitric acid, the excess of acid evaporated, ammonium hydrate added along with magnesia solution, and the arsenic determined in the usual manner as magnesium pyroarseniate, the weighing being made in a platinum crucible, with the following result: 0·2611 gram of niccolite gave 0·2833 gram of magnesium pyroarseniate = 52·52 per cent. arsenic.

Arsenopyrite (*Fe.As.S.*)—The conditions under which arsenopyrite is decomposed are very similar to those of niccolite. The quantity of caustic potash used, the time of decomposition, the reversal of the current, etc., are precisely the same, the only difference between them lying in the fact that in the decomposition of arsenopyrite it was found that the current might vary from one to one and one-half ampères without affecting the decomposition. The method of determining the arsenic, as far as the Gooch crucible, etc., is concerned, was the same as under niccolite. Results as follows:

0·2168 gram of arsenopyrite gave 0·1729 gram of magnesium pyroarseniate = 38·6 per cent. arsenic.

0·1709 gram of arsenopyrite gave 0·1356 gram of magnesium pyroarseniate = 38·41 per cent. arsenic.

The residues from the fusions, treated similarly to those under niccolite, showed no traces of arsenic.

0·2306 gram of the ore were dissolved in concentrated nitric acid, evaporated to dryness, treated with hydrochloric acid and water, and any insoluble matter remaining, filtered off. The solution was then reduced with sulphurous acid, the excess removed by boiling, and the arsenic precipitated by hydrogen sulphide. The solution was then allowed to stand until the odor of hydrogen sulphide was barely perceptible, and then filtered on a porcelain Gooch crucible, washed with cold water, carbon disulphide and alcohol, dried at 100° C. and weighed. The result was 47·73 per cent. As. As the high result could be due to but one cause, viz: the presence of sulphur in the precipitate, repeated treatments with carbon disulphide and alcohol were given the latter, but without avail. The precipitate was eventually dissolved in nitric acid, and the arsenic thrown out with magnesia solution. Found: 0·1856 gram of magnesium pyroarseniate = 38·96 per cent. arsenic.

It will be seen from this, that the determination of arsenic directly as arsenious sulphide by weighing on a porcelain Gooch crucible is not practicable. The method was tried with various other minerals, and in but one case was the result within limits, due more to accident than to any virtues of the method. The difficulty seems to lie in the fact, that the precipitate settles very compactly in the crucible, and prevents the carbon disulphide from obtaining more than a surface contact with it. In some instances, the crucible was placed in a beaker, covered with carbon disulphide, and allowed to stand for twenty-four hours, without any appreciable difference becoming manifest in the result.

Metallic Arsenic (*As.*)—In the oxidation of the metallic arsenic, a difficulty was encountered which the previous minerals had been free from. It was noticed that if the conditions previously mentioned were followed, viz: that the caustic potash be brought to a state of fusion, and the powdered mineral added, a volatilization of some of the arsenic invariably occurred. In fact, so rapidly did this take place, that barely did the mineral come in contact with the fused potash, but what the garlicky odor of arsenic was perceptible. To obviate this loss, the following method was found to be the best, and, in fact, the only one that would give accurate results. The caustic potash was introduced into the crucible, carefully heated to drive out all moisture, and eventually brought to complete fusion. The flame was now removed, and the mass allowed to cool until it was almost solid, when the powdered arsenic was carefully spread over the surface of the potash. The platinum wire is now placed in position and the current closed. Should the potash have cooled to such an extent that the current will no longer pass through the mass, or at least only with difficulty, a very small flame carefully played under the crucible will remedy the trouble. The arsenic, if these directions are complied with, becomes gradually oxidized, and no volatilization is perceptible. After the first ten minutes, the crucible may be gently heated, until its contents are again in a condition of fusion, and should be kept in such a state until the end of the oxidation. The current used for the operation registered one ampère in the Kohlrausch ampèremeter when the potash was completely fused. At the beginning of the oxidation, the resistance offered by the almost solid caustic potash is so great that the current barely registers, but this is exactly the condition that is desirable for thorough results. The current was allowed to run for thirty minutes, being reversed for the last five minutes. The results are as follows:

0·0974 gram of arsenic gave 0·1813 gram of magnesium pyroarseniate = 90·11 per cent. arsenic.

0·1052 gram of arsenic gave 0·1961 gram of magnesium pyroarseniate = 90·23 per cent. arsenic.

The very slight residues which remained after the fusions were treated with water, showed no signs of arsenic. The filtrates from the precipitations with magnesia solution were acidulated with hydrochloric acid and hydrogen sulphide added, to see if possibly some of the arsenic might be present as arsenious acid. No trace of the latter, however, was found.

Another sample of the powdered metal was dissolved in nitric acid, and the arsenic determined in the manner already indicated for the previously mentioned minerals, as magnesium pyroarseniate. It yielded 90·14 per cent. arsenic.

In the two determinations of arsenic in the metallic arsenic, given above, the magnesium pyroarseniate was weighed on porcelain Gooch crucibles.

Rammelsbergite $(Ni.Co.Fe.)As^2$.—With this mineral more difficulty was encountered than with any other, and the results that are given below were obtained only after *seventeen* attempts at decomposition proved unsuccessful. The method used at first was the one which showed itself to be efficient for the decomposition of metallic arsenic, viz: 25–30 grams of caustic potash and a current of one ampère running for thirty minutes, with five minutes reversal at the end of the oxidation. This proved an utter failure, as the residues from the fusion showed in all cases the presence of arsenic, while the results obtained varied from 53–67 per cent. of arsenic. A former experience having shown that the non-oxidation might probably be due to the enclosure of particles of mineral on the platinum wire, a more frequent reversal of the current was tried. Using the same amount of caustic potash, and increasing the current strength from one to one and one-half ampères, the current was reversed after the first ten minutes, and allowed to run in the opposite direction for three minutes. It was then passed up through the crucible again for five minutes, then again down through the platinum wire for three minutes, the process being continued for thirty minutes. The results were altogether unsatisfactory, large quantities of arsenic being found in the residues.

The amount of caustic potash was now increased from 25–30 grams to 40 grams, the nickel crucible used being 1⅞ inches high and 2 inches wide. In six decompositions made under these conditions, the current in the first two had a strength of one ampère, in the second two, of an ampère and one-half, and in the last two it was increased to one and three-quarters ampères, the current being reversed in a manner similar to the one previously tried. The results in all cases were of a negative order, as arsenic was found in all the residues. An increase of the time limit was now tried with satisfactory results. Using forty grams of caustic potash, the current was allowed to act for forty-five minutes. After various attempts to ascertain the best current strength for the purpose, it was found that a current that registers an ampère was the most satisfactory, and it should not be allowed to rise above this point, otherwise the decompositions are apt to be incomplete. In the oxidations given below, the current was reversed at the end of every ten minutes, for three minutes. Another phase of the operation that seems to be essential, is to have the mineral in as fine a condition as possible. Using the conditions just given, the residues from the fusions showed no arsenic, though they were most carefully examined by the wet method and also before the blow-pipe. The arsenic was precipitated as magnesium ammonium arseniate, and weighed as magnesium pyroarseniate in a platinum crucible, the filter being ignited separately after moistening with ammonium nitrate.

The results found were as follows: 0·1829 gram of rammelsbergite gave 0·2598 gram of magnesium pyroarseniate = 68·76 per cent. arsenic; 0·2168 gram of rammelsbergite gave 0·3118 gram of magnesium pyroarseniate = 69·62 per cent. arsenic.

Another sample of the mineral dissolved in nitric acid and determined as magnesium pyroarseniate gave 70·34 per cent. arsenic.

Chloanthite (*Ni.Co.Fe.*) As^2.—The mineral used for decomposition was a portion of the sample from Franklin, N. J., which was reported along with other minerals, by Dr. Koenig, in the *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1889, 184. The decompositions were made contemporaneously with those of rammelsbergite, and for this reason many of the unsuccessful steps which were made with the latter mineral were also made with the chloanthite. The first oxidations were made with a current of one ampère, using 25–30 grams of caustic potash, and allowing the current to run for thirty minutes. As with the rammelsbergite, so here, too, only diverse results were obtained. Reversing the current every five minutes, after the first ten minutes, brought about a similar condition of affairs. The results were from five to six per cent. low. The addition of copper oxide, as recommended by Dr. Smith in the oxidation of pyrite (*Journal of the Franklin Institute*, proceedings of the Chemical Section, vol. 2, p. 62) was now tried. The quantity of caustic potash used being increased at the same time, with one sample of the chloanthite, an equal amount of copper oxide was mixed, and with another sample double the quantity of copper oxide. The other conditions were a current of one and one-half ampères, a time limit of thirty minutes, with reversals of the current after the first fifteen minutes, and forty grams of caustic potash. This combination of conditions gave no better results than the previous one. Satisfactory results were eventually obtained under the following conditions, the copper oxide being dispensed with entirely: The current was not allowed to register above one ampère, and the best results will be obtained if it is kept slightly below this mark. Thirty minutes was found to answer for complete decomposition, but for the sake of certainty, it is advisable to allow the current to run for forty-five minutes, reversing it during the last five minutes. The amount of caustic potash used was forty grams. The results obtained were as follows: 0·2332 gram of chloanthite was decomposed as above. The fusion was treated with hot water and filtered. The filtrate was acidulated with hydrochloric acid, and warmed to expel the carbon dioxide present. On cooling, the arsenic was reduced with sulphurous acid, and after the expulsion of the excess of sulphurous acid, was precipitated with hydrogen sulphide in the cold. The precipitate of arsenious sulphide was filtered in a Gooch crucible, after the solution had stood until it barely had the odor of hydrogen sulphide, and washed with cold water. The crucible and its contents were then placed in a beaker, carbon disulphide added and allowed to stand twenty-four hours. The crucible was then removed from the beaker, its contents washed with alcohol, then with cold water, and finally dried for six hours at 105° C.; 0·2710 gram of arsenious sulphide was found = 70·84 per cent. arsenic; 0·2899 gram of chloanthite treated in the same manner as the preceding gave 0·3325 gram of arsenious sulphide = 69·93 per cent. arsenic.

In the sample of the mineral analyzed by Dr. Koenig and reported by him, he found 70·66 per cent. arsenic.

As will be seen from the above, accurate results were obtained by weighing the arsenic as arsenious sulphide. They are, however, but two out of a large number of determinations that were made in porcelain Gooch crucibles, and the only two which gave results sufficiently close to be utilized. The amount of sulphur precipitated with the arsenious sulphide must have been very small, otherwise the results, owing to the inefficacy of the carbon disulphide, would assuredly have been high. For this reason, the author cannot recommend the method for general use.

The residues from the fusions were carefully examined for arsenic but none was found to be present.

Smaltite (*Co.Ni.Fe.*) As^2.—From the experience gained with rammelsbergite and chloanthite, it was found very easy to oxidize the smaltite. The mineral used for the purpose was mixed with gangue, and therefore was first broken up, and the smaltite picked out as carefully as possible by hand. The resultant material, as shown by the analyses, still contained impurities. The conditions for oxidation are as follows: A current of one ampère with the restrictions imposed under chloanthite, a time limit of forty-five minutes, and forty grams of caustic potash. Using those conditions, the oxidation is complete, the residues showing not the least trace of arsenic. The results obtained were as follows:

0·2233 gram of smaltite gave 0·2813 gram of magnesium pyroarseniate = 60·98 per cent. arsenic.

0·1790 gram of smaltite yielded 0·2199 gram of magnesium pyroarseniate = 59·47 per cent. arsenic.

The method of procedure resembled one already given. The fusion was acidified with hydrochloric acid, then made alkaline with ammonium hydrate, and the arsenic precipitated with magnesia solution, being finally weighed in a platinum crucible. In the latter of the two determinations, the garlic odor of arsenic was noticeable on igniting the filter paper, although it had previously been thoroughly saturated with a concentrated ammonium nitrate solution. This accounts for the slightly low result obtained, but it was not thought necessary to repeat the operation, since the residue showed that the oxidation was complete.

0·3136 gram of the ore, dissolved in nitric acid, and the arsenic determined as magnesium pyroarseniate in a platinum crucible, gave 0·3929 gram of magnesium pyroarseniate = 60·65 per cent. arsenic. The difference in percentage from the theoretical amount is due to the impurities in the mineral.

A study of the composition of rammelsbergite, chloanthite and smaltite will show several points of interest. It will be seen from their formulæ that they each contain two atoms of arsenic to the molecule, while niccolite, cobaltite, arsenopyrite, etc., either have one atom of arsenic to the molecule or have one atom of arsenic replaced by sulphur.

Returning to the study of the conditions necessary for oxidation, it will be remembered that the amounts of caustic potash necessary, and the extents of time, were larger for the first three minerals than for any of the others, while the oxidations seem to proceed with greater difficulty. A cause for this that might be advanced, is that the oxides of the metals are united with greater tenacity to two arsenic atoms than they are to one, and require a greater expenditure of force for their separation. A somewhat similar occurrence was noticed by Dr. Smith in the oxidation of the metallic sulphides. Pyrrhotite, whose formula is in all probability either $Fe_{11}S_{12}$ or FeS, is decomposed with great readiness, while pyrite, which contains two atoms of sulphur to the molecule, succumbed only after repeated and many fruitless trials. What might be considered a curious feature in the oxidation of these arsenides is the fact that those containing two atoms of arsenic to the molecule are decomposed more readily by weak currents than they are by strong ones, while with the arsenides containing but one atom to the molecule, either strong or weak currents are equally efficacious. The only explanation that there is to offer for this seeming anomaly, is the one already given, viz: the enclosure of particles of metal on the platinum wire. In those arsenides containing but one atom of arsenic to the molecule, the decomposition is in all probability so rapid, that any enclosure of the mineral on the wire is practically impossible. In minerals like rammelsbergite and chloanthite we may assume that the decomposition proceeds by much slower stages, so that if the current is sufficiently strong to deposit metal on the cathode, there is constantly present sufficient undecomposed mineral to be enclosed in the deposited metal.

Cobaltite (*Co.Fe.*)*As.S.*—This mineral was decomposed with great ease, a result to be expected if we trace the similarity in composition between it and such minerals as gersdorfite, niccolite, etc. The conditions for oxidation are very similar to those of gersdorfite, with the difference, that while, in the latter, the current was allowed to run only for twenty minutes, in the decomposition of cobaltite it ran for thirty minutes, with a five minutes reversal at the end. Otherwise the conditions for oxidation and for the subsequent decomposition of the fusion and the estimation of the arsenic, are the same as for gersdorfite. The magnesium pyroarseniate was weighed in platinum Gooch crucibles, the method being very accurate, owing to the fact that there is no possibility for any volatilization of the arsenic, and more rapid than weighing in a porcelain Gooch crucible, since the platinum crucible attains a constant temperature in a very short period of time. The results obtained were as follows:

0·1032 gram of cobaltite yielded 0·1006 gram of magnesium pyroarseniate = 47·2 per cent. arsenic.

0·1326 gram of cobaltite yielded 0·1313 gram of magnesium pyroarseniate = 47·93 per cent. arsenic.

0·2250 gram of the same ore was dissolved in nitric acid, the acid evaporated, the solution made alkaline with ammonium hydrate, and the arsenic precipitated with magnesia solution. The resultant magnesium ammonium arseniate was ignited in a porcelain Gooch crucible and gave 0·2229 gram of magnesium pyroarseniate = 47·96 per cent. arsenic.

Orpiment (As_2S_3).—The preliminary investigations made with this mineral showed that it came under the same category as the metallic arsenic. When the finely powdered mineral was introduced into the molten caustic potash, a volatilization of the arsenic, recognizable by its odor, occurred. The precautions given under metallic arsenic, regarding the cooling of the caustic potash and the regulation of the current, were then introduced, with successful results. Some difficulty may at first be experienced in obtaining correct control of the operation, but a few oxidations will give the operator sufficient experience to bring the decomposition to a successful completion. The conditions best adapted for the work are a current of one ampère, 25–30 grams of caustic potash, the current being allowed to run for thirty minutes. Using these conditions, no arsenic was found in the slight residues which remained after decomposing the fusion, nor was any odor of arsenic perceptible during the entire course of the operation.

0·1443 gram of orpiment, decomposed according to the directions, gave 0·1761 gram of magnesium pyroarseniate = 59·08 per cent. arsenic.

0·1044 gram of orpiment yielded 0·12805 gram magnesium pyroarseniate = 59·38 per cent. arsenic.

0·2233 gram of the same ore, dissolved in nitric acid, and weighed as magnesium pyroarseniate in a platinum crucible, yielded 0·2755 gram of magnesium pyroarseniate = 59·72 per cent. arsenic.

Proustite (Ag_3AsS_3).—But a very small quantity of the mineral was available for analysis, and even that was intimately mixed with argentite. No attempt was therefore made to extract the former mineral by hand-picking, but the entire mixture was placed in an agate mortar and ground, the grindings then being passed through a sieve. This removed all the proustite with some of the argentite, the greater portion of the latter remaining behind as flattened plates. Sufficient argentite, however, remained with the proustite, to reduce in a considerable measure the percentage of the arsenic, and the deviation of the results from the theoretical percentage is attributable to this cause. Sufficient material was not at hand to make a check analysis, by dissolving the mineral in nitric acid and determining in the usual way, but as the residues were most carefully examined for arsenic, and as none was found to be present, the natural conclusion arrived at was, that the decomposition was complete. No loss of arsenic was noticeable during the entire operation, and the closeness of the results indicates that the decomposition of this mineral by the electric current can be accomplished as successfully as any one of those previously described. The conditions for oxidation were as follows: A current of one ampère running for thirty minutes, the current being reversed during the last five minutes. The amount of caustic potash used was 25–30 grams. Below will be found the results obtained:

1·1589 gram of proustite, weighed as magnesium pyroarseniate in a porcelain Gooch crucible, gave 0·0147 gram of magnesium pyroarseniate = 4·48 per cent. arsenic.

0·2255 gram of proustite yielded 0·0249 gram of magnesium pyroarseniate = 5·34 per cent. arsenic.

Besides these minerals already recorded, several others were subjected to oxidation by the current, but owing to lack of material for the continuance of the work, satisfactory conclusions were not reached. The results are, however, of interest, and are, therefore, here appended.

Domeykite in Niccolite, $n(Ni.As.) + m(Cu^3As.)$—The mineral used for oxidation came from Michipicoten Island, and was a small section of a specimen in the mineral collection of the University of Pennsylvania, labelled whitneyite. Two oxidations of the mineral, in which the residues still showed arsenic, gave, to the surprise of the author, 35·3 per cent. and 40·04 per cent. of arsenic, respectively, showing that the mineral could not be whitneyite, since this should contain theoretically 11·64 per cent. of arsenic. A later oxidation gave, using 0·2207 gram of the mineral, 0·2016 gram of magnesium pyroarseniate = 44·22 per cent. arsenic. 25–30 grams of caustic potash were employed, with a current of one to one and one-half ampères, for thirty minutes, reversing the current at the end for five minutes. In this oxidation no trace of arsenic was found in the residue. On reporting the results obtained to Dr. Koenig, he made an analysis of another sample, by dissolving the mineral in nitric acid, and found it to contain 47 per cent. of arsenic. This result is, however, not inharmonious with the last one obtained by the current, since, in a fresh fracture of the mineral, the niccolite and domeykite can be seen lying alongside of each other. Owing to this non-homogeneity, the sample analyzed by Dr. Koenig may have contained more niccolite than the one used for oxidation by the current, and gave proportionately a higher percentage of arsenic. Unfortunately, the scarcity of the mineral necessitated the discontinuance of the work, and the question of complete oxidation is still in doubt. The few per cent. difference in the results obtained by the two methods, however, indicates that the decomposition can be successfully accomplished under the conditions mentioned above.

Enargite $(3Cu^2S.As^2S^5)$.—The material used for decomposition contained an admixture of gangue, and as with the domeykite, not sufficient of the substance was obtainable to settle thoroughly the question of oxidation. As the percentage of arsenic found, however, is within the neighborhood of what the mineral ought to contain, and as no arsenic was detectable in the residue from the fusion, the result obtained is here appended, without any definite statement regarding the thoroughness of the method. The amount of caustic potash used in the oxidation was 25–30 grams, the current strength one ampère, with a reversal of the current at the end of the operation for five minutes. The arsenic was determined by weighing as magnesium pyroarseniate on a porcelain Gooch crucible.

0·2840 gram of enargite gave 0·0770 gram of magnesium pyroarseniate = 13·12 per cent. arsenic.

The theoretical percentage of arsenic in the mineral is 19·1 per cent. If we remember, however, that the sample used contained gangue material, and that no arsenic was found in the residue, it is but fair to assume that the result lies within the limits of error, and that the oxidation is complete. No positive statement, however, can be made.

A study of the methods used for the determination of the arsenic in the various oxidations, will be of interest. As has already been stated, the determination of the arsenic as arsenious sulphide, by weighing on a porcelain Gooch crucible, cannot be recommended, owing to the great difficulty experienced in removing the sulphur with which the precipitate of arsenious sulphide is contaminated. The more common method of weighing the arsenic as magnesium pyroarseniate was found to be accurate, if the conditions laid down for this determination are complied with, the method requiring at the same time great care. In the incineration of the filter from the magnesium ammonium arseniate, constant vigilance was required to prevent a volatilization of a portion of the arsenic, even though the filter had been previously saturated with a concentrated ammonium nitrate solution. And in many cases it was necessary to moisten the burnt filter several times with the solution before it could be completely reduced to ash. Weighing the precipitate on either a platinum or porcelain Gooch crucible removes these sources of error, and is, of all the methods so far mentioned, the most to be recommended. In the precipitations with magnesia solutions, it was noticed that the presence of large quantities of alkaline salts has a tendency to materially retard the precipitation of the magnesium ammonium arseniate, and it became necessary to allow the solution to stand at least forty-eight hours before the precipitation was complete. For this reason, where large quantities of alkaline salts are known to be present, for example, the caustic potash used in the fusion, it may be more advisable to reduce the arsenic with sulphurous acid, precipitate it as arsenious sulphide, filter and wash, and then reconvert it into arsenic acid and determine as magnesium pyroarseniate.

Owing to the time and care required in the above determinations, the method described in *Sutton's Volumetric Analysis*, sixth edition, as recommended by Pearce, of the Colorado Smelting Company, was tried. The substance of the method is as follows: "The arsenic brought into the form of alkaline arseniate is acidified with nitric acid, and boiled to remove carbon dioxide and nitrous fumes. It is then cooled to the ordinary temperature, and almost exactly neutralized as follows: Place a small piece of litmus paper in the liquid; it should show an acid reaction; now gradually add strong ammonia until the litmus turns blue, avoiding a great excess. Again make slightly acid with a drop or two of strong nitric acid, and by means of very dilute ammonia and nitric acid, added drop by drop, bring the solution to such a condition that the litmus paper, after having previously been reddened, will, in the course of half a minute, begin to show signs of alkalinity. The litmus paper may now be removed and washed, and the solution, if tolerably clear, is ready for the addition of silver nitrate. If the neutralization has caused much of a precipitate (alumina, etc.), it is best to filter it off at once, to render the subsequent filtration and washing of the arseniate of silver easier, ——." The latter portion of the process consists in determining the silver in the silver arseniate, and calculating the percentage of arsenic from the amount of silver found.

A number of determinations were made by the author to ascertain the value of the method, but all of the attempts made resulted in failure. It was found well nigh impossible to tell by the color of the litmus paper whether the solution was acid or alkaline. In several cases, methyl orange was used as an indicator, and while the solution was made slightly alkaline, as recommended by Pearce, the addition of ammonia to the filtrates invariably brought down considerable quantities of silver arseniate, and the results obtained were proverbially low. The silver was not determined by titration, as recommended by Pearce, but by electrolysis. The best results obtained by this method, with the details of the operation, are given below:

A sample of rammelsbergite was decomposed under the conditions mentioned for that mineral. The fusion was decomposed with hot water, the insoluble material filtered off, and the clear filtrate acidified with nitric acid and boiled to remove the carbon dioxide. On cooling, ammonium hydroxide was added, the precipitated alumina, etc., filtered off, and the additions of dilute nitric acid and dilute ammonia made according to Pearce's direction, until the solution became faintly yellow, methyl orange having been used as an indicator. Silver nitrate was now added, the solution stirred, and the precipitate of silver arseniate filtered off. The addition of a drop of ammonium hydrate to the clear filtrate gave a further precipitation, and ammonia was, therefore, added until the precipitation was supposed to be complete. The two precipitates were then united, washed with cold water, dissolved in nitric acid and the excess of acid evaporated. To the solution, ammonium hydrate was added until the solution became alkaline, and then an excess of potassium cyanide, the solution electrolyzed and the resultant silver weighed. 64·21 per cent. of arsenic was found, the same sample giving, by the pyroarseniate method, 70·34 per cent. arsenic.

The author believes that with continued practice, sufficient dexterity might be obtained with the method to obtain accurate results, but it is hardly one that could be recommended for work outside of a technical laboratory, where absolute accuracy is not so essential a feature, as that the results should be correct, relatively, to each other.

A comparison of the oxidation of the metallic sulphides with that of the metallic arsenides shows several points of difference. In the oxidation of the sulphides, it was observed by Dr. Smith that the process took place in three stages, the sulphur being first oxidized to hydrogen sulphide, then to sulphurous acid and eventually to sulphuric acid. A similar state of affairs was not observed with the arsenides, and the oxidation evidently proceeds directly from metallic arsenide to arsenic acid. Even in samples where the oxidation had not been complete, and where the residues still showed undecomposed material, the filtrates from the fusion showed no trace of arsenious acid after the alkaline arseniate had been removed by precipitation with magnesia solution.

In conclusion, the author would here express his sense of deep obligation to Dr. Edgar F. Smith, for his unremitting kindness during the progress of the above work, and for his constant help in assisting its completion.

Thanks are also due to Dr. George A. Koenig for samples of minerals, and to Mr. D. L. Wallace, of this laboratory, for assistance rendered in the oxidations.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, August 3, 1891.

PROCEEDINGS.

[*Stated meeting held Tuesday, December 15, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, December 15, 1891.

Dr. W. H. WAHL, President, in the chair.

Present, ten members and one visitor.

Dr. Jayne moved that the by-laws be suspended and the regular order of business be done away with. Carried.

The resignations of Messrs. Stevens and Gudeman were accepted by the Section.

A motion renewing the subscriptions to the various periodicals, and authorizing the treasurer to pay for the same, was carried.

The paper of the evening was by Prof. Jos. W. Richards, on "The Specific Heat of Aluminium."

After a *résumé* of the work already done in that direction, Prof. Richards brought forward the results recently obtained by him. The paper was referred for publication.

The meeting then adjourned.

LEE K. FRANKEL, *Secretary pro tem.*

THE SPECIFIC HEAT OF ALUMINIUM.

BY J. W. RICHARDS, Lehigh University.

[*Read at the stated meeting of the Chemical Section, held December 15, 1891.*]

The determinations of the specific heat of aluminium are but few in number, and yet vary widely.

As soon as Sainte-Claire Deville had obtained a button of aluminium, in 1855, his friend Regnault importuned him for a specimen with which to determine its specific heat, and although Deville knew that the metal he had made was far from pure, yet he yielded to Regnault's request and furnished him with three small pieces, which analyzed:

Silicon,	2·87
Iron,	2·40
Copper,	6·38
Lead,	traces
Aluminium,	88·35

Regnault determined the mean specific heat of this metal between 25° and 97° to be 0·2056. He attempted to calculate approximately the specific heat of pure aluminium by allowing for the impurities present. In doing this he assumed the specific heat of silicon to be 0·1425, it not having been then determined, and his calculation gave him 0·2181 as the number for pure aluminium. Had he, however, used what we now know to be the specific heat of silicon, 0·21, he would have calculated 0·2200 as the specific heat of pure aluminium between 25° and 97°.

A year later Regnault obtained aluminium about 97 per cent. pure. He obtained for this, between 14° and 97°, 0·2122. Allowing for the impurities present, he calculated 0·2143 as the probable number for pure aluminium.

It may be remarked in passing, as a curious fact, that Regnault treats these mean values as if they were invariable constants, independent of the range of temperature through which they were determined.

Following Regnault came Kopp, who in 1863 made determinations with ordinary Parisian aluminium. He obtained 0·2020 as the mean value between 20° and 52°. However, no analysis is given of the metal used, and from a consideration of the way in which Kopp experimented, and the degree of accuracy which was possible in his experiments, it is evident that his results are of very little value. For instance, four determinations gave him

0·1970
0·2000
0·2070
0·2020

from which he simply deduces 0·2020 as an average value.

In 1882, Professor Mallet made some absolutely pure aluminium for his researches on the atomic weight, and he determined its mean specific heat between 0° and 100°, by means of a Bunsen ice calorimeter, to be 0·2253. Since no impurity was present in the metal, this determination is free from one of the sources of error of the previous ones.

More recently, Naccari, the noted Italian physicist, states that he obtains for the true specific heat of aluminium at various temperatures the following values:

18°	50°	100°	200°	300°
0·2135	0·2164	0·2211	0·2306	0·2401

It will be noticed that these values indicate that the specific heat increases 0·0095 per 100°, and lead to the formulæ:

$$S = 0{\cdot}2116 + {\cdot}000095\,t$$
$$Sm = 0{\cdot}2116 + {\cdot}0000475\,(t_1 + t_2)$$

in which 0·2116 is the true specific heat at 0°. The mean between 0° and 100° would be 0·2164, comparing well with Regnault's results, but much lower than Mallet's. It is not stated what was the purity of the metal used by Naccari.

The question which the writer set out to solve presented itself to him in this way: Who is nearest the truth, Regnault and Naccari, or Mallet?

I obtained some aluminium made by the Hall process, which analyzed:

Silicon,	0·07
Iron,	trace
Aluminium,	99·93

Since the atomic weight of silicon is almost identical with that of aluminium, it was felt safe to neglect the influence of the 0·07 per cent. present.

Three methods of procedure were used. First, a large weight of aluminium (100–200 grms.) was put into an empty calorimeter, whose water equivalent had been accurately determined by experiment, and allowed to stand several hours. When the temperature was nearly constant, a known weight of water at a higher temperature was run in, and the total loss of heat calculated from the observations. This method gave mean specific heats between about 16° and 22°. Secondly, the aluminium was suspended in steam and dropped into the water in a calorimeter. This gave values from 20° to 100°. Thirdly, two exactly similar calorimeters were used. The aluminium and a platinum ball weighing fifty-two grammes were placed on a platinum support and heated together either in an air bath to 120°, or in a small furnace up to 400°, 500° and 600°. The platinum ball was dropped into one calorimeter and the lump of aluminium into another. From the heat given out by the platinum its temperature was calculated, and assuming that the aluminium had been at the same temperature, I had the data for calculating its mean specific heat.

The third method gave the most concordant results. The first method was used for such a small range of temperature that the experimental errors were large. The second method was defective in default of suitable apparatus to secure the instant transfer of the metal from the steam into the calorimeter. The third method had the advantage, that since the platinum and aluminium were taken out of the furnace together and were dropped almost simultaneously into the calorimeters, it could fairly be assumed that they would cool about the same amount in the two or three seconds during which they were exposed to the air.

The writer has made two experiments by the first method, five by the second and sixteen by the third. Selecting those experiments, which were experimentally the nearest to perfect ones, and correlating the data by the method of least squares, the following formulæ were arrived at:

$$\mathrm{Sm} = \mathbf{0{\cdot}2220} + \mathbf{0{\cdot}00005}\,(t_1 + t_2)$$
$$\mathrm{S} = \mathbf{0{\cdot}2220} + \mathbf{0{\cdot}0001}\,t$$

in which 0·2220 is the true specific heat at 0° C.

From these formulæ the following values will be shown:

Temperature.	*True Specific Heat.*	*Range of Temperature.*	*Mean Specific Heat.*
0°	0·2220	0° — 100°	0·2270
20°	0·2240		
100°	0·2320		
		0° — 625° (melting point)	0·2533
625° (melting point)	0·2845		
		Total caloric capacity to the melting point,	158·3

It is seen that the author's results confirm Mallet's determination, as far as the true specific heat is concerned, and agree closely with Naccari's observation of its rate of increase with the temperature.

LIST OF CHEMICAL JOURNALS ACCESSIBLE IN THE LIBRARY OF THE FRANKLIN INSTITUTE.

(1) American Chemical Journal, Baltimore. 1879—date.
(2) American Chemical Society Journal. 1879—date.
  Proceedings, New York City. 1877—date.
(3) American Chemist. 1870–1877.
(4) American Journal of Science. 1818–1845.
  American Journal of Science and Arts. 1845–1879.
  American Journal of Science. 1880—date.
(5) Analyst (London). 1879—date.
(6) Annalen der Pharmacie. 1832–1839.
  Annalen der Chemie und Pharmacie. 1840–1873.
  Justus Liebig's Annalen der C. und P. 1873—date.
(7) Annalen der Physik und Chemie.
  Journal der Physik (Gren). 1790–1794.
  Neues Journal der Physik. 1794–1798.
  Annalen der Physik. 1799–1818.
  Annalen der Physik und der physikalischen Chemie (Gilbert). 1819–1824.
  Annalen der Physik und Chemie (Poggendorff-Wiedmann). 1824—date.
  Beiblätter. 1877—date.
  Ergänzungsbände. 1842–1878.
(8) Annales de Chimie et de Physique. 1817—date.
(9) Chemical News. 1860—date.
  Chemical Gazette. 1843–1859.
  Chemical News. 1860—date.
(10) Chemical Society (London):
  Memoirs. 1841–1848.
  Proceedings. 1841–1843.
  Quarterly Journal. 1849–1862.
  Journal. 1862—date.
(11) Chemical Trade Journal. Current.
(12) Chemical Society of Washington. 1886—date.
(13) Chemiker Zeitung. Current.
(14) Chemisches Centralblatt. 1856—date.
(15) Deutsche chemische Gesellschaft. Berichte. 1868—date.
(16) Polytechnisches Journal (Dingler). 1820—date.
(17) Gazzetta Chimica Italiana. Current.

(18) Jahresbericht über die Fortschritte auf dem Gebiete der reinen Chemie (Staedel). 1873–1881.

(19) Jahresbericht über die Fortschritte der chemischen Technologie (Wagner). 1855–1860.
  Jahresbericht über die Fortschritte und Leistungen der chemischen Technologie (Wagner). 1861–1880.
  Wagner's (R. von) Jahresbericht über die Leistungen der chemischen Technologie (Fischer). 1881—date.
(20) Jahresbericht über die Fortschritte der physischen Wissenschaften (Berzelius). 1822–1841.
  Jahresbericht über die Fortschritte der Chemie und Mineralogie. 1842–1851.
(21) Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technologischen Chemie. 1847–1856.
  Jahresbericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften. Kopp und Will, Naumann, Fittica. 1857—date.
(22) Journal für Physik und physikalische Chemie. Current.
(23) Journal für praktische Chemie.
  Allgemeines Journal der Chemie (Scherer). 1798–1803.
  Neues allgemeines Journal der Chemie. 1803–1806.
  Journal für die Chemie (Bucholz). 1806–1810.
  Journal für Chemie und Physik (Bernhardt). 1811–1833.
  Journal für praktische Chemie (Erdmann). 1834—date.
(24) Journal of Applied Chemistry. New York City. 1866–1875.
(25) Journal of Analytical and Applied Chemistry. Easton, Pa. 1887—date.
(26) Monatshefte für Chemie. Current.
(27) Oil, Paint and Drug Reporter (unbound) 1882—date.
(28) Repertorium der analytischen Chemie. 1881–1887.
(29) Société Chimique de Paris, Bulletin. Current.
(30) Society of Chemistry, London, Journal. 1882—date.
(31) Tschermak's Mineralogische Mittheilungen. Current.
(32) Zeitschrift für angewandte Chemie.
(33) Zeitschrift für analytische Chemie. 1862—date.
(34) Zeitschrift für die chemische Industrie. 2 vols. 1887—
(35) Zeitschrift für Krystallographie und Mineralogie. Current.
(36) Zeitschrift für physikalische Chemie. Current.
(37) Zeitschrift für physiologische Chemie. Current.

REPORT OF THE CHEMICAL SECTION OF THE FRANKLIN INSTITUTE FOR THE YEAR 1891.

Mr. Joseph M. Wilson, President Franklin Institute.

SIR:—I have the honor to submit the following report of the proceedings of the Chemical Section, for the year 1891.

A consideration of the present condition of the section, and also of its history during the past year, shows that it has made very satisfactory progress for that interval. The work was prosecuted with the aid of the following officers:

President, Dr. Wm. H. Wahl.
Vice-Presidents, { Mr. H. Pemberton, Jr.
Dr. Wm. H. Greene.
Secretary, Dr. Wm. C. Day.
Treasurer, Dr. H. W. Jayne.
Conservator, Dr. Wm. H. Wahl.

Stated meetings were held as required by the by-laws, on the third Tuesday of each month, excepting July and August.

Membership:—The number of members on the treasurer's books at the beginning of the year was seventy-two; since that time twenty new members have been elected, eight have resigned. and two were dropped for non-payment of dues; this making a net gain of ten, or a total membership of eighty-two.

Finances:—The report of the treasurer recently submitted to the Section shows a cash surplus in the treasury, after paying the current expenses of the year.

The attendance upon the meetings has been satisfactory throughout the year, and fully equal to that of 1890.

The highest purpose that the section can serve is, of course, in its capacity as a medium for encouraging and stimulating original research among chemists. That this purpose has been promoted during the past year is well demonstrated by the fact that twenty-nine papers, giving the results of original investigation, were read before the section and published in the *Journal* of the Institute. In addition to these, four other communications were presented, thus making a total of thirty-three subjects of scientific interest which were considered at ten regular meetings.

Very respectfully submitted,
WM. C. DAY, *Secretary*.

3 1198 03572 6186

N/1198/03572/6186X

WERT
BOOKBINDING
MIDDLETOWN, PA.
JAN 82
We're Quality Bound

3 1198 03572 6186

N/1198/03572/6186X